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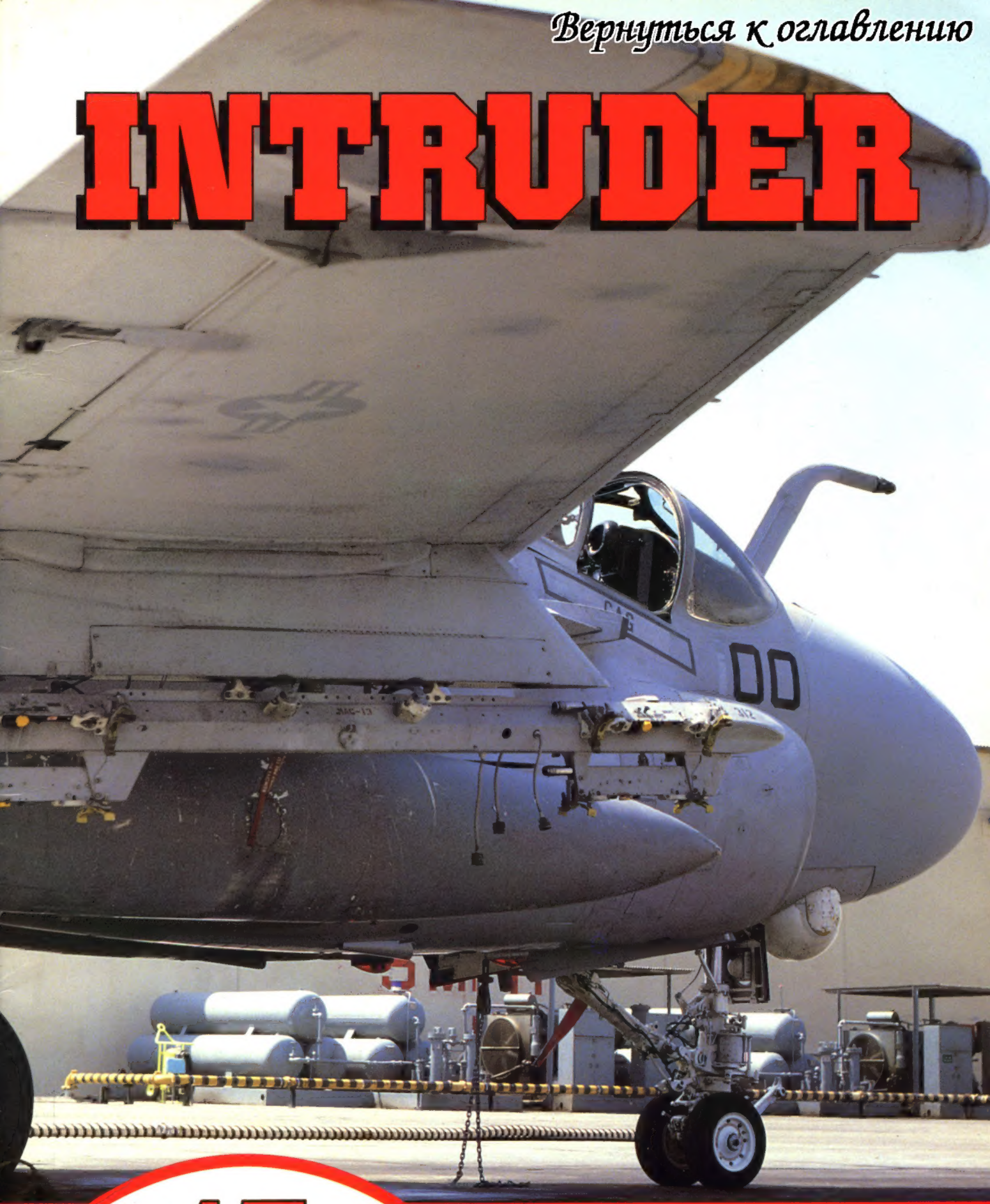
INTRUDER



AEROGUIDE 15

Grumman A-6E Intruder

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GRUMMAN A-6E INTRUDER

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Cover photo: A Grumman A-6E TRAM Intruder on the VMA(AW)-121 flight line at MCAS El Toro, spring 1985.

Back cover plate: An A-6E of VMA(AW)-533 ('Hawks') in 1981 decor. The aircraft is fitted for TRAM but has yet to have the nose turret installed.

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INTRUDER

US Navy

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Grumman A-6E Intruder

INTRODUCTION

It became readily apparent during World War II, the first conflict in which carrier aircraft played a really significant part, that the naval air commander faced two enemies. One was the nation mounting the offensive against his country and all that that implied, particularly its shipping but also (and more and more importantly as the war was carried towards its homeland) its ground forces and their equipment, supply lines and communications network, and its industrial base. The other enemy was the elements – the lousy weather that so often prevented him from carrying out his job, usually at a critical moment.

Coupled with this was an inherent difficulty in actually finding certain types of targets. A ship, perhaps a couple of hundred feet long, not only stood out in isolation from its surroundings when it was under way, but it also very conveniently left behind it a wake maybe hundreds of yards in length. A land target like an airfield was not all that more difficult to spot, given reasonable weather. If, however, a factory had to be located, or worse still a mobile target such as a road convoy, the chances of success were rather more remote.

Although artificial aids were promising to come to the commander's rescue by the close of World War II, radar-assisted navigation and bombing enabling both sea-going and land-based objectives to be hit with increasing accuracy, the advent of the atomic bomb seemed to point to the fact that high-precision weapons delivery might not, after all, be that important: one detonation would wipe out large numbers of targets at a stroke and, with the Soviet Union and its sprawling land mass seen as the only potential foe in the immediate postwar world, a few dozen of these detonations, well placed, would win any conflict.

The threat to the Fleet would not come from any surface ships – at the time the Soviet Union had few of any consequence – but from land-based aircraft and from submarines. Alongside the strategic bombers, therefore, the fleet carriers would need air defence fighters, preferably jets, and specialised ASW aircraft; the latter could be offloaded on to specially modified escort carriers, of which the US Navy had an over-abundance.

Then, in 1950, came the Korean War, which rather upset the grand design. Suddenly the splendid nuclear bombers and the sophisticated ASW aeroplanes were unusable, and it became obvious that the aircraft which was really needed here – a machine that could be called up by the troops on the ground, irrespective of the weather, to support them in their fight by hitting any enemy target that happened to be causing them a problem at the time – had had its requirement squeezed out. Within a few years design teams all over the United States were hard at it studying ways to plug the gap. The most convincing proposals came from team headed by Lawrence M Mead and Robert Nafis at Grumman – a not altogether surprising choice since no company had more experience in producing carrier-based aircraft. The aircraft they had in mind would be called, appropriately, the Intruder.

Opposite page: An A-6E Intruder, braking in mid-air, comes aboard the carrier *Nimitz*, July 1981. The aircraft shows the markings of Medium Attack Squadron 35 (VA-35), and the tail code letters 'AJ' indicate that it is assigned to Carrier Air Wing 8 (CVW-8). *US Navy*

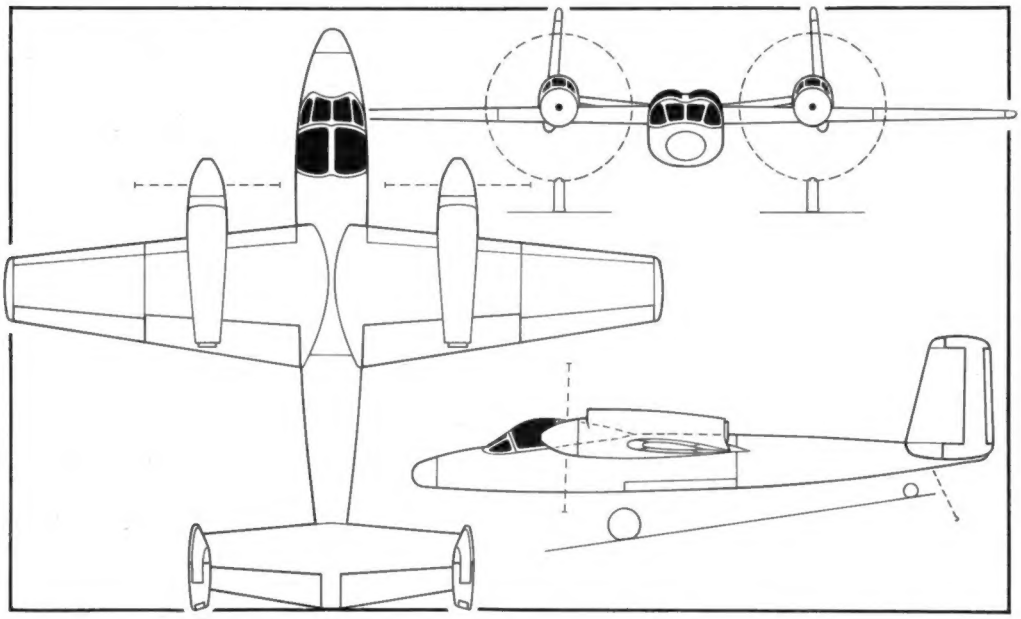
Below: A dramatic view of an A-6E, emphasising the aircraft's massive radome and 'cheek' intakes. *Grumman Corporation*

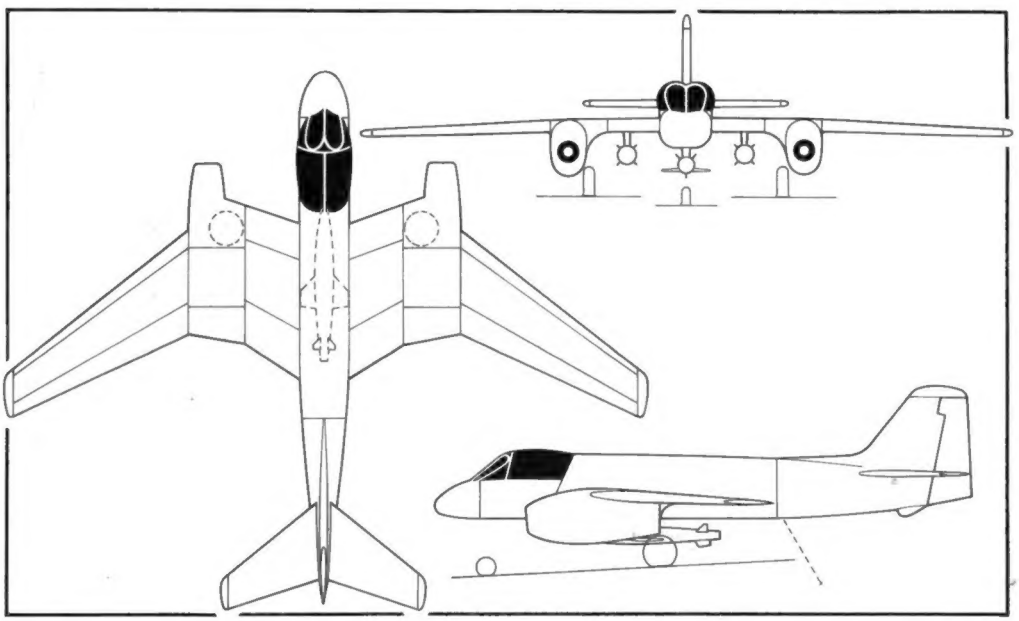
DESIGN & DEVELOPMENT

In mid-1956 a Request for Proposals (RFP), Type Specification 149, was formally issued to the American aircraft industry. The response was enthusiastic: no fewer than twelve submissions, from eight different companies, landed on the desk of the Head of the Bureau of Aeronautics (BuAer) in the summer of the following year. The requirement was the one shown to be unfulfilled during the Korean War – an effective, all-weather, close-support aircraft that could be flown from carriers. The challenge was enormous, not least because it implied great sophistication: such aids as radar bomb sights were familiar to aircrews of attack squadrons, but nobody had yet come up with a carrier aircraft that could search for, find and destroy a land target without visual reference either en route to the target or over it; nor one that could do this without assistance from any land-based radio data links; nor one that could do it in any weather. Design 128, submitted by Grumman, promised to meet all these needs.

TS.149 was not particularly detailed, but it did stipulate a two-man flight crew; all-weather, day/night attack capability; mission radii of 300nm for close-support and 1000nm for long-range interdiction; and a speed not less than 500kts. In addition, of course, it had to be carrier-compatible, which meant great airframe strength, a sturdy undercarriage and a low stalling speed, plus the basic problem of getting the aircraft down carrier lift shafts. A special feature of TS.149, however, caused the Grumman designers some head-scratching: the aircraft had to have good STOL characteristics so that the Marines could fly it from short airstrips close to the beach-head. In more general terms, the new aircraft would fill the gap between the Douglas A4D Skyhawk light bomber (see AEROGUIDE 14) and the North American A3J Vigilante strategic bomber then under development; in essence, it would displace the piston-engined Douglas AD Skyraider, which was, despite the A4D, still very much a front-line attack aircraft.

During the second half of 1956 and the first half of 1957 the Grumman design team worked its way through a series of study configurations, building up the best possible aeroplane around the BuAer specifications and chatting to personnel from operational attack squadrons to see what sort of machine they would like. The important fixed elements were the massive search and track radars needed to meet the mission, the two crewmen to cope

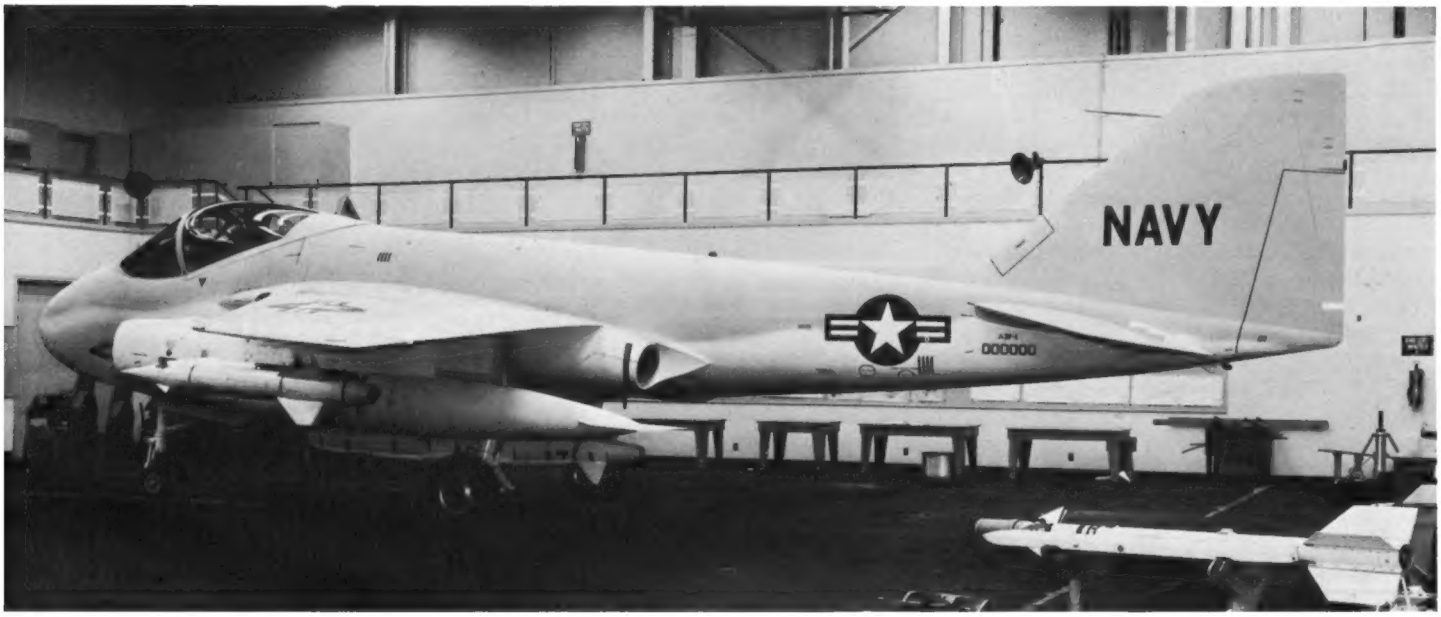




Left: Design 128Q formed the basis for Grumman's winning submission for the TS.149 competition, and was arrived at after a great deal of intensive study, involving more than a dozen preliminary configurations. Two of the early, rejected designs are shown here. Design 128F (top) featured twin turboprops (presumably Allison T56s), twin tail fins and an enormous rotary bomb bay; 128M4 (lower drawing) showed an unusual 'M-wing' layout, which proved to be too heavy and complicated to be worth pursuing, and J52 turbojets mounted in low-slung nacelles.

Opposite page top: The A2F-1 mock-up, displayed in 1959 after Grumman had won TS.149. A major role envisaged for the Intruder was acting as a launch aircraft for the Corvus nuclear missile, but the latter was cancelled; however, a dummy Corvus is carried on the centreline station here, along with Bullpups on the outer wing pylons. *Grumman Corporation*

Opposite page bottom: The first flight of the A2F-1, 19 April 1960, took place some days before the official roll-out, the aircraft being left in bare-metal finish. Configuration changes needed on production machines proved to be merely cosmetic. The 'tadpole' shape is obvious. *Grumman Corporation*

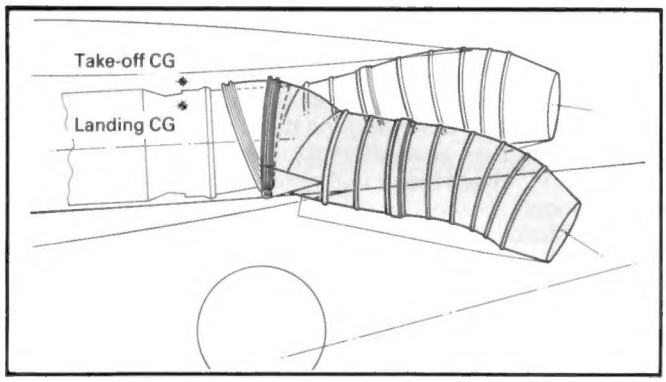


with the workload, and a wing of low wetted area and moderate sweep-back, for good cruise characteristics at high subsonic speeds. Twin engines seemed the best bet, given the need to power what would obviously be a large machine through the air and the need to do so over long distances and hence reliably. Good single-engine control was also mandatory, best achieved by placing the powerplants close together. Then the bomb load and undercarriage had to be fitted in, as near as possible to the centreline in order to maintain airframe structural strength without too great a weight penalty. Finally there were the special carrier-dictated features. The close-support role would involve flying from *Essex* class carriers with their hydraulic catapults, and the maximum folded wing span would be 25ft 4in, so that two aircraft could pass each other through the fire doors fitted across the carriers' hangars. Overall length was limited to 56ft, to fit carrier lifts.

A novel feature of Design 128Q, the final submission, was an early application of the vectored thrust principle. To meet the Marine Corps' STOL specification – a take-off distance of 1500ft to clear a 50ft obstacle – variable-geometry tailpipes were fitted to the J52 engines. Angled down at 23 degrees, these enabled take-off speeds to be cut by about 10 per cent and take-off distance to be considerably reduced. Although this ingenious device was dispensed with on production aircraft, it was without doubt an important factor in Grumman winning the design competition.

On 26 March 1959 everything was formalised with a contract: Gumman would develop their design – now called the A2F – into hardware and build eight aircraft, the costing coming out at just over $100 million; further big orders would follow. Within a few weeks the metal was being cut for the first Intruder. It wasn't all that much different from Design 128Q. The wing was cleaned up a bit to straighten out the trailing edge and its double-slotted flaps were exchanged for simpler, single-slotted components, whilst the span was increased by a couple of feet to improve cruise drag (incidentally allowing an extra 1000lb of fuel to be worked in); the fin was enlarged and moved back along the tail empennage; air conditioning capacity was doubled; a CSDU (constant speed drive unit) was fitted; and a few alterations were made to the canopy.

It's not unheard of for a new aeroplane to make its first flight before its public unveiling, but it's not all that



Above: The first A2F prototype, now resplendent in pale grey and white paintwork, executes a low pass, demonstrating its vectoring tailpipes. Leading-edge slats and trailing-edge flaps are also at full extension. *Grumman Corporation*
Left: Diagram illustrating the operation of the A2F's 'tilting tailpipes'. The fittings were omitted from all production aircraft after No 7.
Below: Another view of the first aircraft, here toting four underwing fuel tanks and with air brakes open. *Grumman Corporation*
Opposite page: The third (nearest camera), fourth and second A2F fly in formation. No 3 shows the repositioned horizontal stabiliser and No 4 the nose-mounted refuelling probe. *Grumman Corporation*

common, especially nowadays. It happened with the A2F: on 15 April 1960 BuNo 147864 was put on a truck at Bethpage and moved to Calverton, and five days later it took to the air. The formal roll-out and acceptance ceremony, 28 April that year, was the first public airing for the Intruder, and after this the flight test programme got into full swing.

The vectored-thrust system worked a treat, synchronising correctly with the set of geared elevators installed to keep pitch and trim under control. The airbrakes, flush-fitted either side of the rear fuselage, showed up one design flaw: extending the brakes with power on interfered with the airflow across the horizontal stabilisers and caused the hydraulic actuator to stall as it was unable to cope with the hinge moments. The solution proved quite simple – slide the entire tailplane back 16in. In fact the brakes themselves were later found by the Navy to be less than satisfactory – in particular they did not perform well enough when dive-bombing trials were being held and moreover baffled the exhaust from the jetpipes when opened out, affecting thrust – and so extra, split brakes were fitted to the wing trailing edges, at the tips. The somewhat frightening prospect of one set of the new brakes working and the other not was eliminated by arranging an interlock system, later replaced with a straightforward pressure tee backed up by an electrical fail-safe circuit. Later, Intruders would have their side brakes permanently bolted down; later still, they would be dispensed with altogether. The final major change shown to be necessary as a result of flight testing was to make the rudder bigger, to help the pilot recover more readily from a spin. By the end of 1962, with the A2F now redesignated A-6A and the production lines rolling, the configuration of the airframe had been finalised. Today, almost a quarter of a century later, new Intruders are still trundling out of Calverton, virtually indistinguishable in appearance from those first machines. It's hard to think of another aircraft with a comparable record.

Some things have changed, but they're mostly inside and unseen. US Navy and Marine Corps pilots are second to none in their abilities, but even they can't fly their aircraft through foul weather and pitch darkness without some sort of assistance – and the Intruder is required to do just this. The magic that makes it all work is a box of tricks called DIANE, for Digital Integrated Attack Navigation Equipment (one of the Grumman design leaders concerned with the A2F programme had a daughter called Diane, so perhaps the acronym came first and the words fitted afterwards). This was the technology that was just around the corner during the Korean War, and the important word is 'integrated'. For the first time the term 'GFE' meant something different: the traditional arrangement whereby the airframe constructor would fit into his design all manner of Government Furnished Equipment would be abandoned in favour of using Grumman Furnished Equipment, and the complete weapons system would be sorted out by the people who built the plane. Integrated indeed – and almost unheard of in the early 1960s.

DIANE worked well, though not at first. Its sheer complexity was the main problem, emphasised by the fact that no one had produced anything quite like it before. It had to bring together eleven major electronic systems (and incorporate a host of inputs) and provide a synthetically generated display for the pilot and navigator. The three primary sensors were the Ku-band Norden APQ-92 search radar, the Ku-band Norden APQ-88 (later APQ-112) track radar, and the Litton ASN-31 inertial navigation system (INS); these enabled the aircraft to perform the fundamental tasks of navigating in all weathers to and from the target area, seek out and track both moving and stationary targets, and map terrain ahead to provide the

'pathway in the sky', all helped along with heading, speed and attitude information derived through the INS. Weapons selection and delivery modes were worked out by the Litton ASQ-61 digital (drum-memory) computer, and other systems performed such functions as altitude, ground speed, drift angle and static pressure calculations, whilst communications, subsidiary navigation inputs (for example TACAN) and IFF were looked after by additional sub-systems.

Getting all this to hang together was not much short of a nightmare. The fourth A2F, BuNo 147867, was the avionics trials aircraft. It flew for the first time in December 1960 but the systems barely worked at all. It would take almost another three years before all the bugs were ironed out. One problem was that there had been insufficient laboratory testing – in fact DIANE was never 'bench run' before it was installed in '867; another was the downright unreliability of many of the component sub-systems. Later it was discovered that the cockpit displays were of unacceptable quality, and in April 1962 it was decided to revamp the whole arrangement. The pilot's horizontal display was changed from a 5in TV to a direct-view tube and the navigator's 5in TV to a 7in CRT (cathode-ray tube), resolution was sharpened up and brightness improved. The whole A-6 programme was held up for about a year because of these snags, although it must be remembered that Grumman were pioneering a whole new concept.

In contrast, airframe clearance was proceeding very well indeed. In December 1962 an Intruder was taken aboard the carrier *Enterprise* for compatability trials, whilst others were engaged in long-range demonstration flights, cold-weather tests and polar inertial navigation trials – and of course continuing avionics evaluation. Avionics and Weapons System BIS (Board of Inspection) trials got going in March 1963, shortly after the first two production A-6As were delivered to Navy Attack Squadron 42 (VA-42) at Oceana, Virginia. The first truly operational aircraft, airframe No 32, was handed over on 10 October 1963.

Design 128 always had much more potential than TS.149 called for, and Grumman had from the start striven to give their airframe a significant multi-role capability. For example, specialised anti-submarine warfare (ASW) and reconnaissance variants were emphasised in the company's initial submissions to BuAer. In the summer of 1961 serious design work was begun on a tactical electronic countermeasures (ECM) version of the Intruder; originally designated A2F-1Q (often quoted as A2F-1H), it later became the EA-6A, and the first example, converted from the second A2F to fly, took to the air in February 1963. The EA-6A was developed for the Marine Corps as an aircraft that would support the main attack force by jamming enemy radiation (in its broad sense) and gathering electronic intelligence (elint). Its chief distinguishing features were the massive radome faired into the top of the vertical stabiliser, underwing pods containing ECM gear, and an extra stores station on each wing. The EA-6A retained a strike capability but its successor, the EA-6B Prowler, did not; moreover, the latter was a major redesign rather than an A-6A with 'add-on' equipment. Not least amongst the changes is a reconfigured forward fuselage, accommodating four crewmen instead of two.

Less radical, at least so far as appearance changes were concerned, were the A-6B and A-6C Intruders. Neither version was built in any numbers, both were taken straight off the A-6A lines and modified, and none of either mark is now in front-line service. The A-6B's speciality was radar suppression, and three distinct sub-variants were produced, all equipped to carry the AGM-78 Standard ARM (Anti-Radiation Missile) but each offering slightly

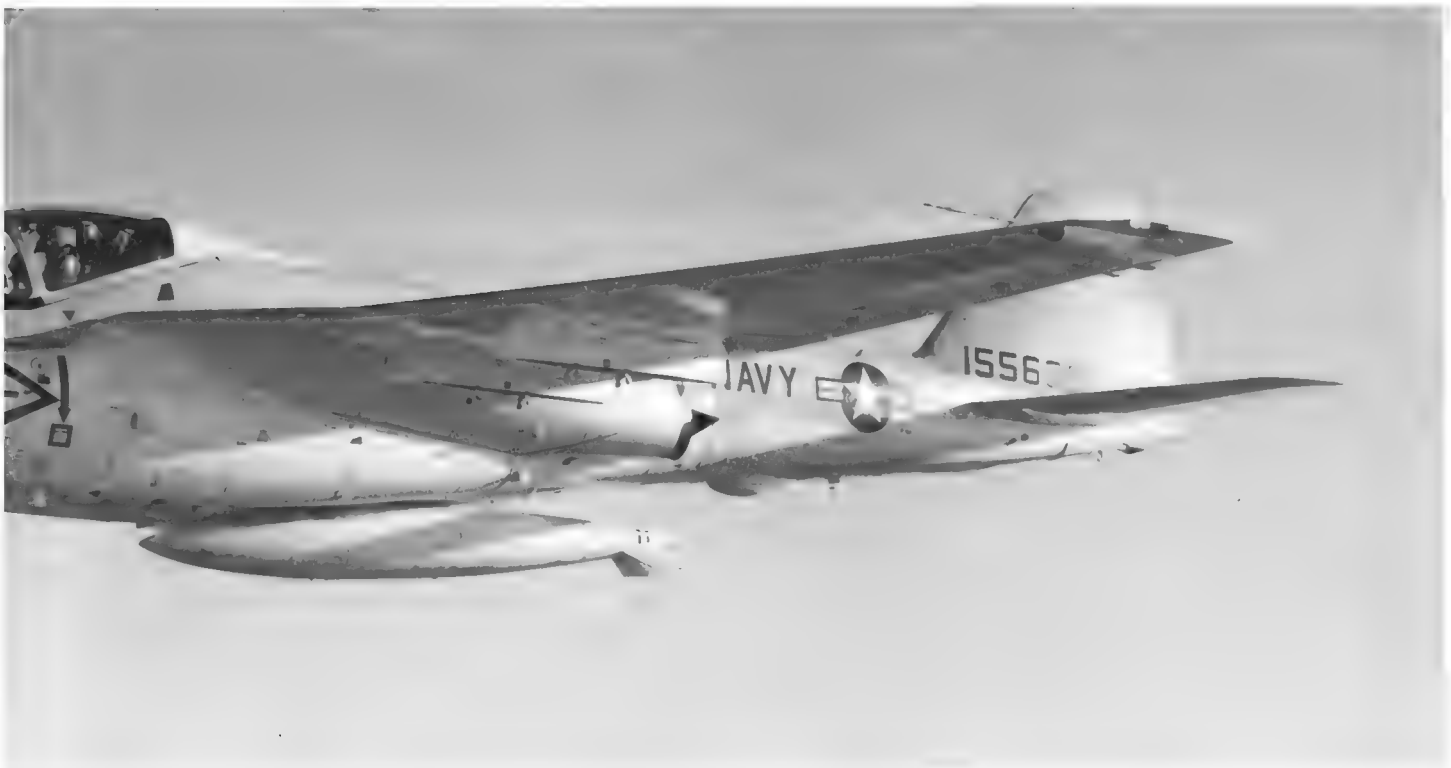
Above left: The fifth Intruder was serialled 148615; it is seen here dumping fuel from its pipe at the tail. Like aircraft No 4 shown in the previous photo, it features the black radome that would become characteristic of the production A-6A. *Grumman Corporation*
Above right: A January 1963 photo of the first prototype, now bearing the legend 'A-6A' above its serial number. Note that the broad, production rudder has been fitted; the aircraft has also been equipped with a tail parachute canister, for spin trials, and a large antenna fairing beneath the rear of the fin cap. *Grumman Corporation*
Right: A factory-fresh production A-6A, sporting a centreline fuel tank, photographed in 1968. The fuselage air brakes had by this time been dispensed with. *Grumman Corporation*

different solutions. The A-6C was optimised for attacking targets that could be detected neither visually nor by radar and carried electro-optical sensors. Rejoicing in the title 'Trails/Roads Interdiction Multisensor', which thankfully abbreviates to TRIM, the equipment included forward-looking infra-red (FLIR) and low-light television (LLTV) in a sizeable ventral tub along the fuselage centreline.

Far less complicated, and used in much greater numbers, has been the KA-6D version of the Intruder. Stripped of the A-6A's black boxes, it is in effect a flying fuel tank and is in widespread US Navy service. Grumman saw the possibilities of using the A-6 in this role at an early stage, and in fact Intruders were used as airborne tankers right from the start, using a 'buddy' pod beneath the fuselage. They still retain this option, but the KA-6D is a dedicated aircraft, equipped with a permanent hose and drogue installation. All the tankers are conversions of early production A-6As.

The really big transformation got under way in the late 1960s, by which time giant strides in electronics technology were starting to make the A-6A look a trifle dated. Doubtless all sorts of aerospace manufacturers got to work on designs that might succeed the aircraft in USN and USMC service, but Grumman were quite convinced at an early stage that the best aircraft to replace the Intruder was another Intruder – filled with the latest goodies from the avionics industry. It speaks volumes for the quality of the airframe that this was precisely the programme that got under way – indeed, a second rejuvenation, still using what is essentially the A-6A airframe, is proceeding apace right now.

Design 128S brought about the A-6E, which started to come off the lines as a brand new production aircraft in 1971–72; however, about two-thirds of the -Es now in service are modified -As, since a major upgrade programme was begun about the same time. The A-6A and the A-6E are hard to tell apart, but inside the fuselage it's a different story. Gone are the APQ-92 and APQ-112 search and track radars, their place taken by Norden's APQ-148 multi-mode system, which combines the two



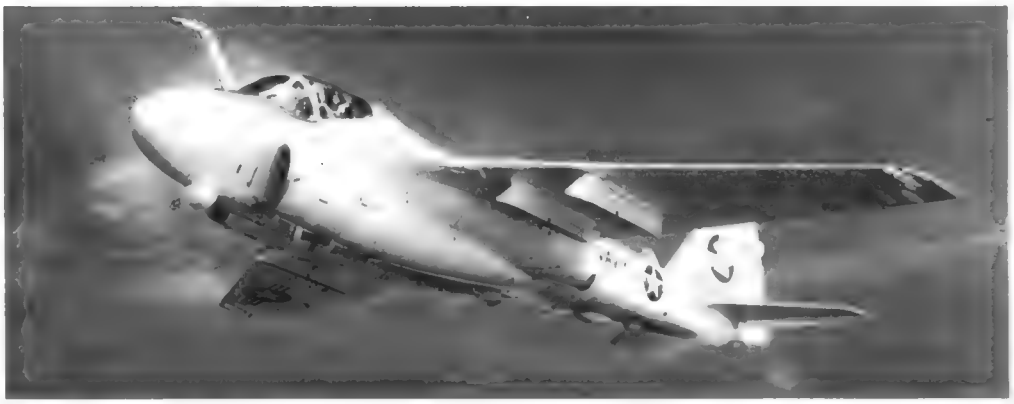
functions in one piece of equipment. Gone is the ASQ-61 rotating-drum computer; instead, an ASQ-133 solid-state model, manufactured by IBM and already chalking up flying time in the A-6's half-sister, the Prowler, was taken on board. Other changes were made, notably the fitting of a new weapons release system, all converting the Intruder from a 1950s-technology aircraft to a 1970s-technology aircraft. The new avionics suite brought large-scale improvements to DIANE, and greater reliability; it reduced flight-crew workload (one nav/attack radar instead of two just has to), and it brought down MMH/FH, or maintenance man-hours per flying hour.

For the 1980s, enter TRAM, for Target Recognition and Attack Multisensor, and this *is* something visible from the outside. Produced by Hughes, it takes the form of a rotating turret built out through the bottom of the nose radome and is in a sense a development of the TRIM programme of the A-6C. It contains a FLIR sensor, a laser designator/ranger and a laser receiver, and it lets the Intruder see things it couldn't pick out before by radar alone, like areas of woodland, strips of roadway and other features related to how land is used rather than man-made things sitting (or travelling) on top of it – although it can of course detect these as well. It also provides greater accuracy than before, in conjunction with the specially upgraded search/track main radar, now relabelled APQ-156. Other changes worked in alongside the A-6E TRAM programme included replacing the ASN-31 INS with ASN-92, bringing the Intruder into line with the rest of the US Navy's front-line carrier aircraft under the CAINS (Carrier Airborne INS) programme; the fitting of ACLS (Automatic Carrier Landing System), complementing the existing approach power compensator (APC); and the provision of dual UHF radios, ARN-84 TACAN and APX-72 IFF under a programme designated CNI to replace the early-generation systems already installed. One aspect of the benefits brought about by switching from the A-6A to the A-6E was that changing the radar reduced the number of black boxes from 23 to 10 and changing the computer meant a reduction from 9 to 5; in both cases, equipment weight was almost halved.

The TRAM refit programme is virtually complete, but re-winging Intruders is now in progress; 68 aircraft had been re-winged as of 1 January 1986. Aircraft are selected according to their expended fatigue life (recorded by an onboard accelerometer counting/tracking system), and the programme had to be stepped up when several aircraft showed hitherto unsuspected cracks in their wings. In summer 1985 it was reported that Boeing had been selected to design and manufacture a new A-6 wing of carbon/epoxy composite but with aluminium control surfaces.

The building of A-6s continues at the rate of half a dozen annually, but in Fiscal year 1988 (FY88) a new version of the Intruder, the A-6F, will enter production. Once again, alterations to the basic Intruder configuration are

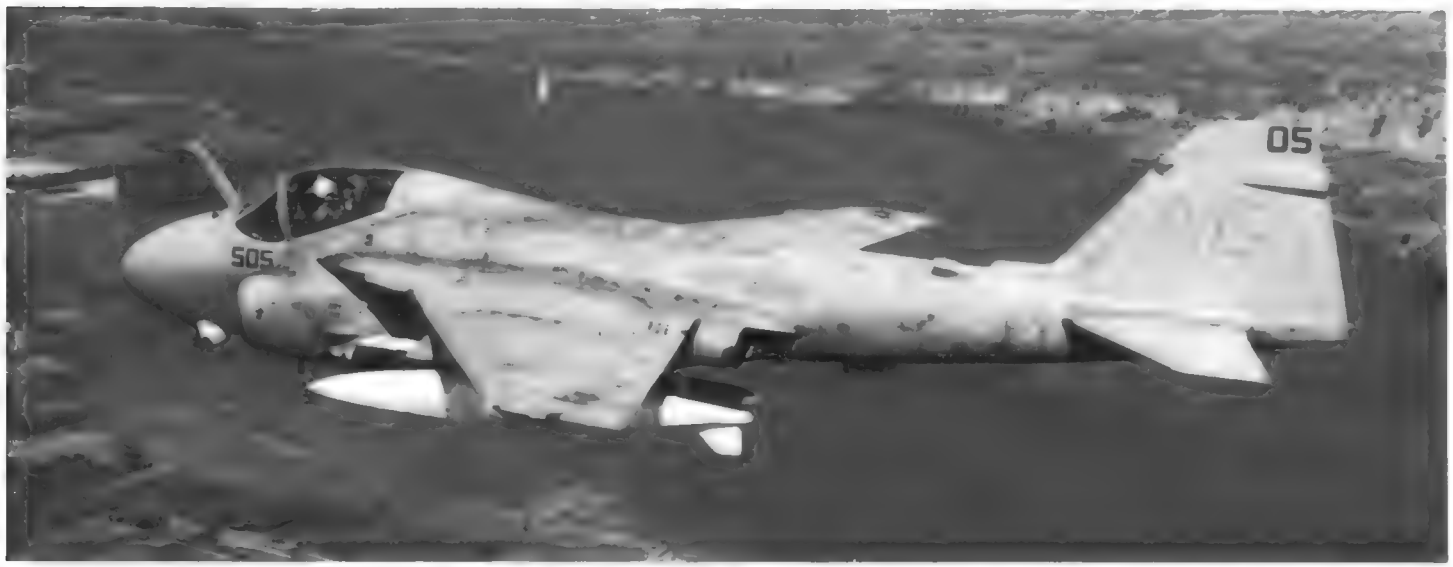
Left: A VA-85 ('Falcons') Grumman A-6A Intruder departs for a mission from its parent carrier, *Kitty Hawk*, off Vietnam, 1966; the aircraft is armed with Snakeye retarded bombs. Intruders were used in large numbers during the conflict in South-East Asia, though mostly against pre-determined targets; maintenance, particularly of the avionics, proved difficult, and aircraft availability was low. *Grumman Corporation*
Below: Flaps spread and tailplane tilted down, an A-6A from VA-176 ('Thunderbolts') soars away from a catapult launch into a gloomy overcast. *Grumman Corporation*



Right: A-6E TRAM development aircraft (actually a reworked A-6A). The special equipment, which is now standard throughout the A-6E fleet, consists of an infra-red/laser tracker mounted in the small turret beneath the nose, enabling Intruder crews to find and attack ground targets with incredible accuracy in pitch darkness. This photo was taken in spring 1974. *Grumman Corporation*

unspectacular, although they do go further than the A-6A to A-6E changeover. The new aircraft will have a slightly longer tail empennage, the new wing, new engines (General Electric F404 turbofans in place of the present P&W J52 turbojets), and extra wing weapons stations. The avionics will once again be thoroughly upgraded (TRAM is being retained) and the latest ECM gear will be fitted. The overall idea is to modernise the Intruder fleet completely and further improve the aircraft's reliability, give it a 'stand off' capability and drastically cut down its chances of being lost to enemy action. Some A-6Fs will, reportedly, be derived from existing A-6Es (though, one might assume, not from A-6Es themselves reworked from A-6As).

The Intruder programme has had more than its fair share of teething troubles, but the A-6 has been the mainstay of the US Navy's medium attack force for a long time, and with the transfer of the strategic mission to submarines in the early 1960s its importance began to outgrow its original specification. Moreover, it will still be around at the end of the century and very likely well beyond. Longevity is sometimes the hallmark of financial constraint, but it is sometimes the proof of outstanding design work. Beyond doubt, the second of these reasons applies to the Intruder.



Above: A not exactly pristine A-6E TRAM, assigned to CVW-7, in low-visibility greys scheme, summer 1983. The US Navy carrier aircraft scheme of pale grey and white was officially phased out from 1980 after a quarter of a century of use. *US Navy*
Right: The current Intruder project is the A-6F, production of which will continue at least until the mid-1990s and perhaps beyond. First deliveries are scheduled for late 1989, at which time A-6E production will be terminated. This photo shows the mock-up under construction. *Grumman Corporation*

STRUCTURE

The Intruder is a deceptively large aeroplane. In terms of overall dimensions (span 53ft, length 54ft 7in) it is rather smaller than, for example, a Canberra, although at around 11½ tons its empty weight is comparable and when toting its maximum weapon load is considerably heavier at around 26 tons. The A-6 is bulky at the front and very slim towards the tail, which gives rise to its oft-quoted 'tadpole' appearance. This is almost wholly a product of the two principal radar systems fitted under the original specification: following the fuselage forward to aft, the radome size was more or less fixed because of the equipment it had to cover; side-by-side crew seating was a 'natural' because of the width made available by the radar gear (and it had the effect of improving crew co-ordiantion); side-by-side engines continued the theme, as well as ensuring minimum single-engine trim requirements, short inlets, short tailpipes, easy maintenance and an aircraft CG close to the thrust vectors; and the rear fuselage was made as slim as possible (consistent with structural strength) since, with everything pushed up front its only important function was to support the tailplane, as far away from the rest of the aircraft as it could be (to make the Intruder as stable as possible in flight).

Most of the fuselage is of traditional semi-monocoque construction, but the lower portion of the front end, around the engines, is built up from a steel/titanium keel member to give optimum strength and heat resistance. Elsewhere, the structure is made essentially from aluminium alloy. The wings are of longer span than one might expect, given the A-6's low-altitude role and the low-aspect-ratio wings that are normally favoured for this type of mission, but all sorts of factors entered into the design argument, for example maximising lift at low speeds (critical, since the aircraft has to land aboard carriers), maximising weapons carriage (external, on wing pylons) and maximising fuel capacity (giving the necessary range). Wing sweepback is 25 degrees, an arrangement compatible with the high subsonic speeds required of the aircraft, and leading-edge slats and trailing edge flaps occupy almost the entire span. Conventional ailerons were rejected in favour of spoilers (flaperons) fitted to the upper wing surfaces, operating differentially for lateral control but also, if necessary, deploying together during landing runs to act as an auxiliary braking system. The tailplane is of slab, all-moving design.

The undercarriage, immensely strong as would be expected, is the usual tricycle type. The main wheels retract into the fixed wing gloves, which results in a good, wide track without taking up wing space that is better employed holding up pylons. The nose gear incorporates a catapult linkage for flight deck operations – one of the earliest examples of this arrangement.

Power for the Intruder comes from two Pratt & Whitney J52 turbojets, similar to the engines installed in later versions of the A-4 Skyhawk. The A-6E uses J52-P-8As, each offering 9300lb of thrust; afterburners are not fitted. Internal fuel tankage allows for about 16,000lb of JP5, or approximately 2350 US gallons (1960 Imperial gallons), distributed in nine tanks, three in the fuselage (above the engines) and three in each wing (one each in the glove section, the inboard wing proper and the hinged outer section, all integral with the wing structure).

Below: VMA(AW)-121 ('Green Knights') A-6E TRAM in Light Gull Gray/Insignia White finish, 1985.
Right: The Intruder's unique layout gives the aircraft a forward fuselage that is almost triangular in cross-section. 'Cheek' intakes fit snugly beside the nosegear bay and lead through to closely paired J52 turbojets tucked beneath the wing roots.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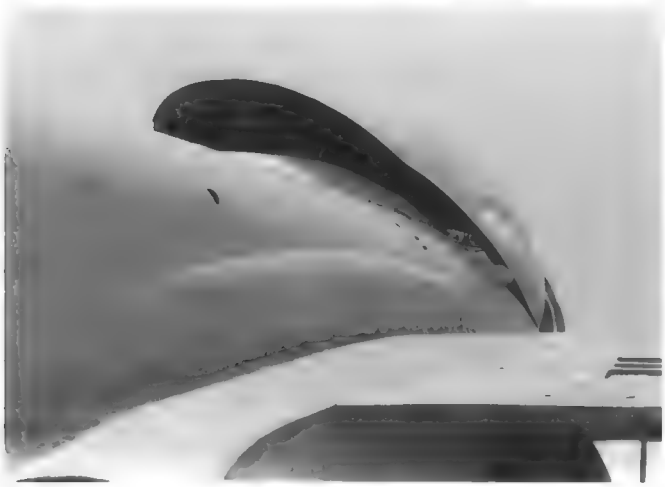
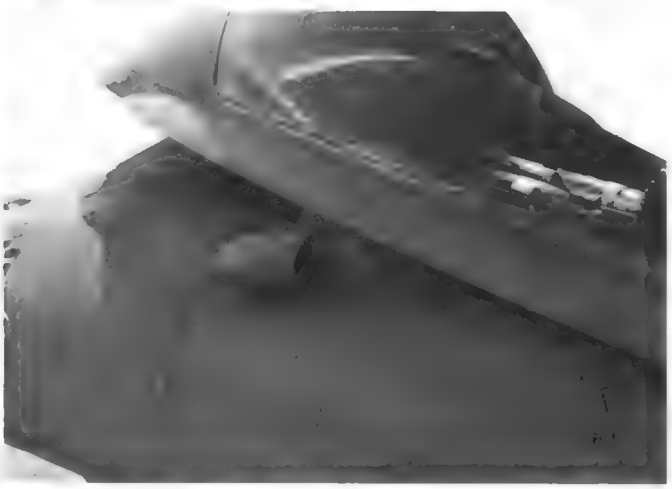
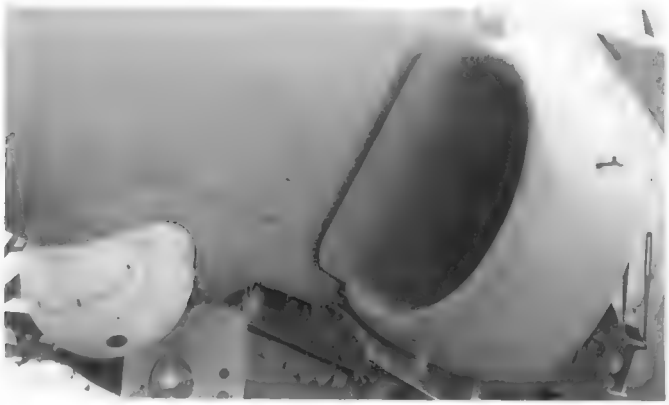
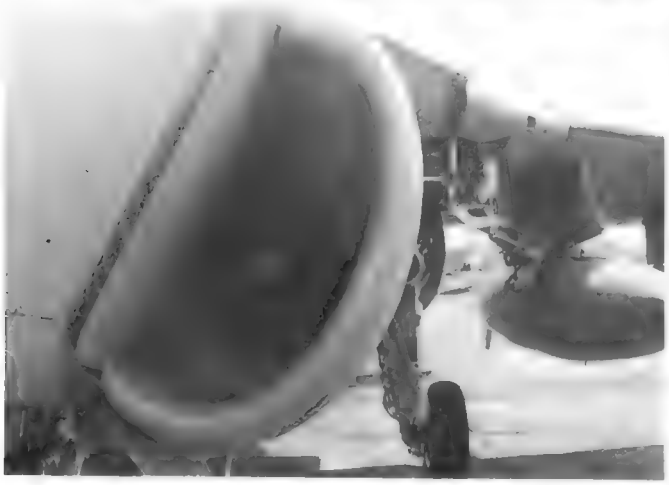


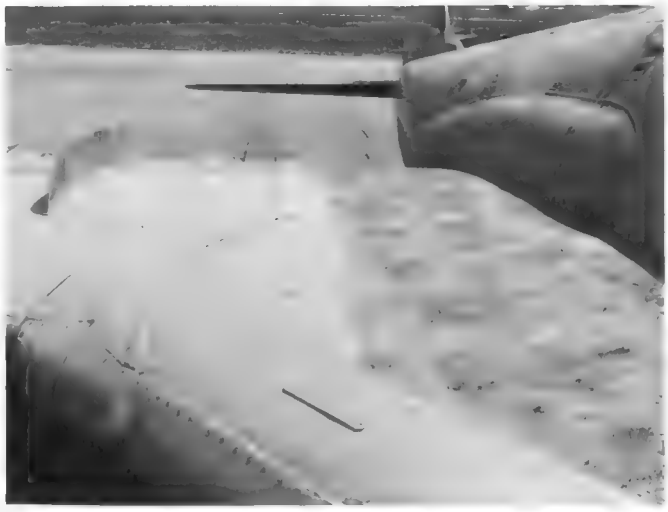




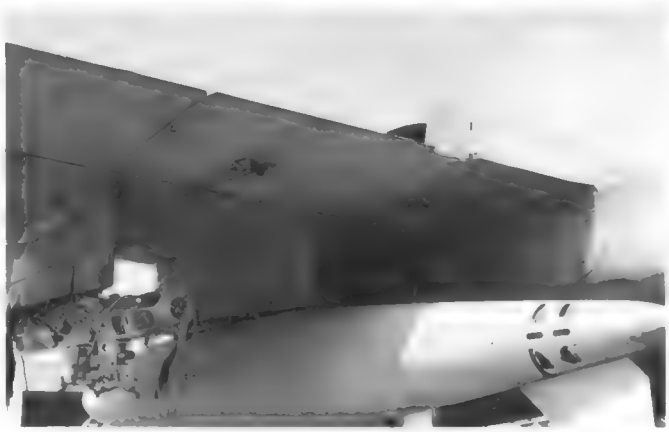


Opposite page: The cockpit canopy is necessarily broad and is of the simple sliding variety. Fitted centrally at the base of the split windshield is the refuelling probe, which is theoretically removable but in practice is rarely absent. Early Grumman drawings show that a refuelling boom mounted on the port wing was once a serious prospect.

Above: Close-in views of the port main intake; the run through to the compressor face is quite short, with engines well forward. Note TRAM turret in front of nosewheel bay and integral, fold-down cockpit access steps.
Below: Rear aspect of an A-6E, showing how the tailpipes are canted downwards, assisting lift during take-off.



Above: Upper wing details, with wing root non-slip walkway panel prominent.
Right: Undersurfaces of inboard flap, showing track rails.
Below: Trailing-edge flaps in extended position; spoilers (flaperons) lie flush with the wing just forward of the track fairings. Note fuel dump pipe on trailing edge at left and emergency ram air turbine in raised position at right.
Opposite page top: A VA-65 ('Tigers') A-6E Intruder at speed. Visible on the leading edge of the outboard wing pylon is one of a pair of ALQ-100 boom-mounted tactical jammer antennas, now replaced by ALQ-126 in the wing itself. *US Navy*
Opposite page bottom: A splendid overhead view of an A-6E TRAM, showing to perfection the layout of the wings, control surfaces, tip brakes, fences, fold hinge lines and walkways. Notches in flap trailing edges allow full activation when wing tanks are carried. *Grumman Corporation*



Above: A dramatic view of a Snakeye-equipped A-6E TRAM of CVW-3, 1986. The thin red streak along the leading edge of the port wing flap indicates that the spoiler there is activated, doing the same job as a conventional aileron. *Grumman Corporation*

Below: US Navy VA-128 ('Golden Intruders') A-6E, 1985. This is another former A-6A airframe. Upper anti-collision light is situated on the fin leading edge. *Grumman Corporation*

Opposite page: Further angles on the A-6E's wings. Notice especially the massive hinge fairings for the wing-tip air brakes, the RWR antenna fairing beneath the wing tip and the fixed spoiler along the leading edge of the wing glove. The RAT at the port wing root provides emergency electric power in the event of main systems failure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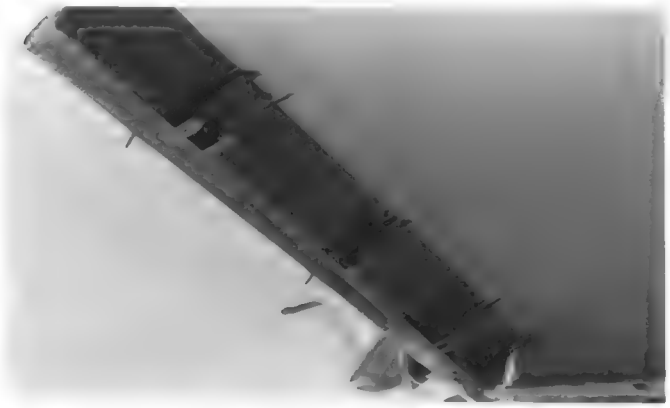
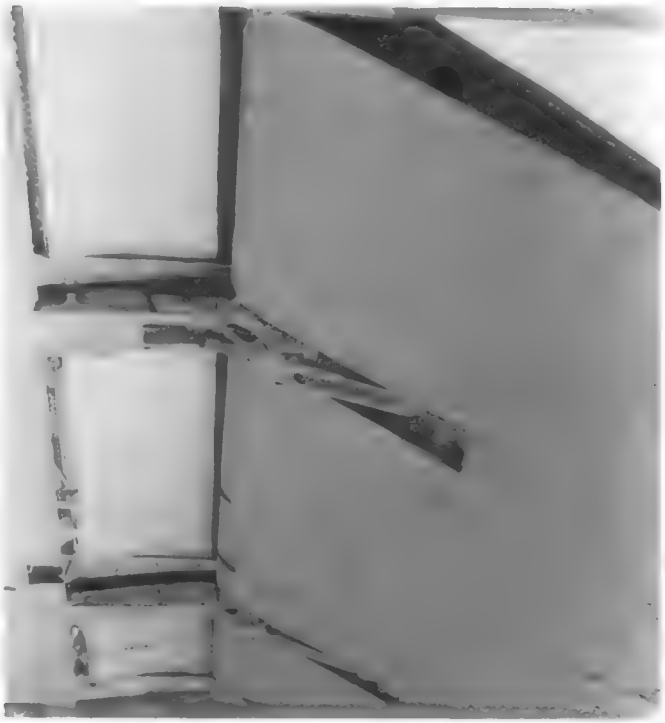
Above: An A-6E assigned to VA-85 ('Falcons') comes aboard – a favourite pose for the Intruder photographer. *Grumman Corporation*

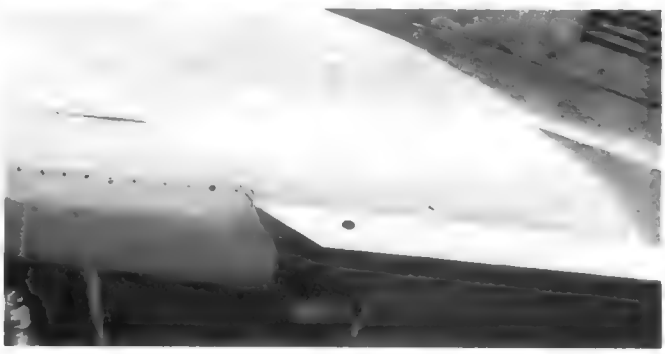
Below: An A-6E Intruder from VMA(AW)-242 ('Batmen'), US Marine Corps. The aircraft shows the early 'swiss cheese' perforated air brakes, and this feature, together with the low Bureau Number, indicates that it was originally built as an A-6A. Note the small practice bombs carried on the underwing ejector racks and the extra air scoop at the base of the fin leading edge, the last showing that the aircraft is fitted for (though not yet with) TRAM. *Grumman Corporation*

Opposite page top: A-6E TRAM 'Double Nuts' of VMA(AW)-121, MCAS El Toro, the subject of the four-view drawing on pages 34–35. Despite the changeover to low-visibility paintwork, inside surfaces of slat areas and other moving components are, unlike some other aircraft types, still painted red.

Opposite page bottom: A glimpse inside the cockpit of a Marine Corps A-6E TRAM; notice in particular the slightly staggered arrangement of the ejection seats.







Opposite page: Starboard rear fuselage and jetpipe. The main undercarriage does not, as might at first appear, retract straight into the engine bay: the two powerplants are located near to the aircraft's centreline and exhaust through somewhat contorted tailpipes shaped like a shallow 'S'. The bulge beneath the fuselage visible on the left of the top photo houses the A-6's doppler radar, part of a complete avionics bay which swings downwards for maintenance etc.
Above: Bolted-up ex-air brake panel, port side; note low-voltage formating strip light above.
Below: Extra dorsal cooling intake applicable to A-6E TRAM model (left) and arrester hook bay (right).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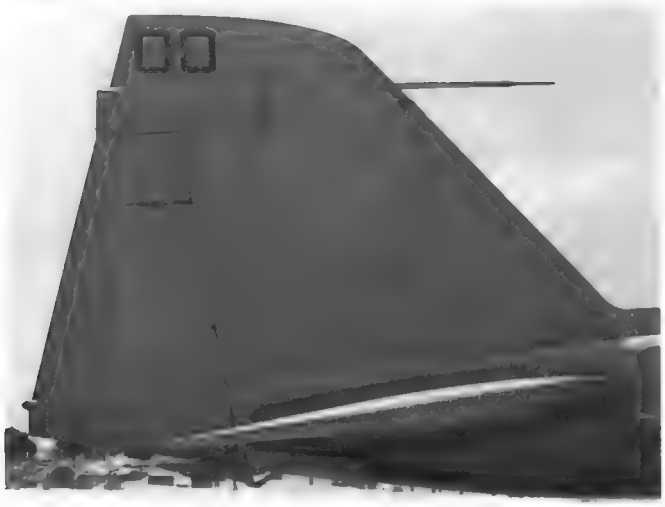
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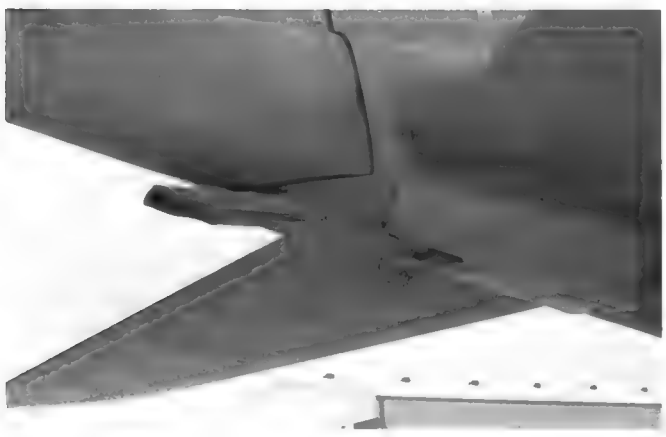


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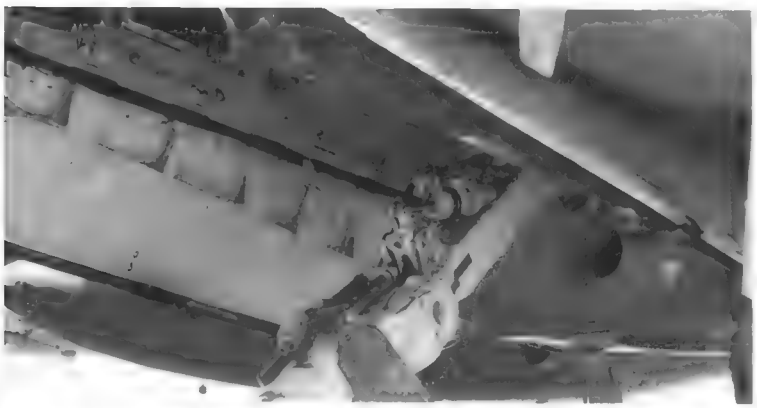
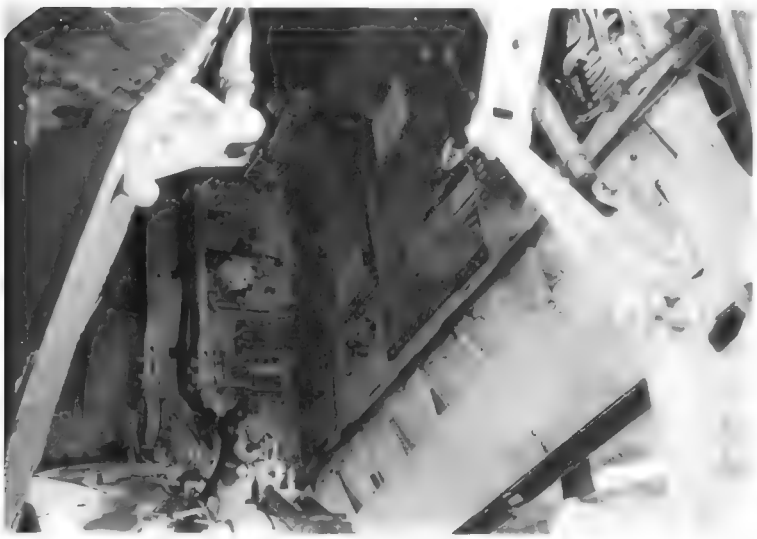
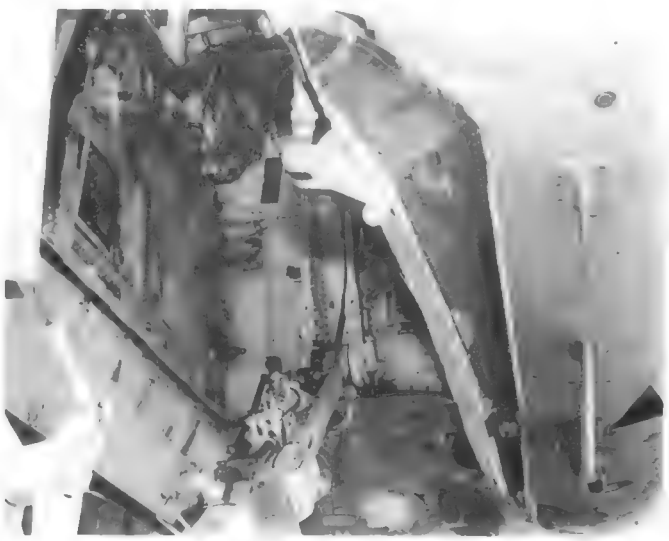


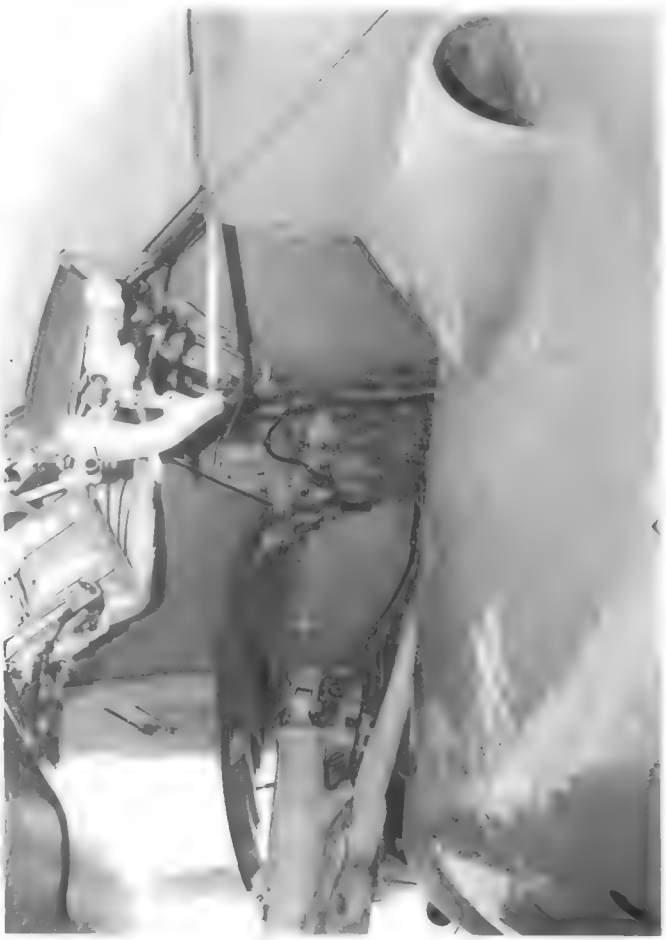
Opposite page: Tail fin details of a 'Green Knights' Intruder. Tail navigation lamp is located at base of rudder trailing edge; beneath, adjacent to the hinge line, is the fuel dump pipe that takes care of the fuselage tanks. The rudder has a travel of 4 degrees either side in the normal flight regime, limited by a series of flap-operated stops; for low-speed manoeuvring and spin recovery the stops open up to a maximum of 35 degrees.
This page: The Intruder's massive nose gear, an inverted 'pneudraulic' shock strut fitted with a drag brace for retraction and a catapult tow link at the front; the brace and tow link fold between the wheels when the undercarriage is retracted inside the bay. The forward nosebay door features a landing/taxying light and three carrier approach lights. A hydraulic steering system is incorporated; the unit is fitted to the starboard side of the main strut.

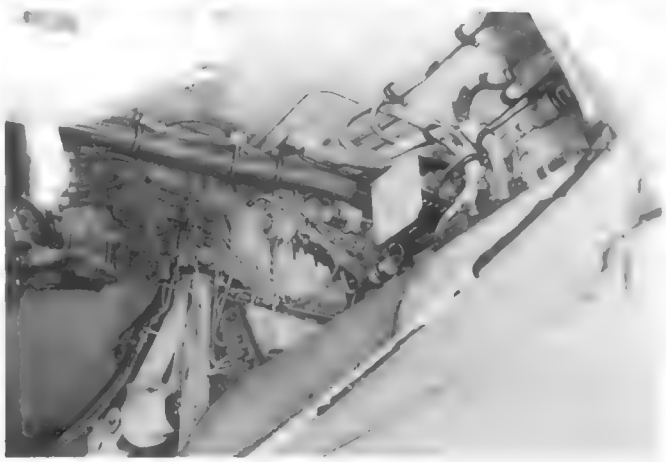




This page: Port main undercarriage gear details; the mainwheel struts are the 'right way up', as shown by the position of the torque links. Retraction and extension of all three gear units are effected hydraulically; in case of failure, compressed air bottles provide for emergency extension.

Opposite page: Starboard main gear unit and wheel bay. Swinging forward into wing root fairings, the Intruder's main undercarriage has a reasonably wide track without taking up valuable wing space better employed for stores carriage. The main wheels have to turn through 82 degrees to lie flat.





MISSION

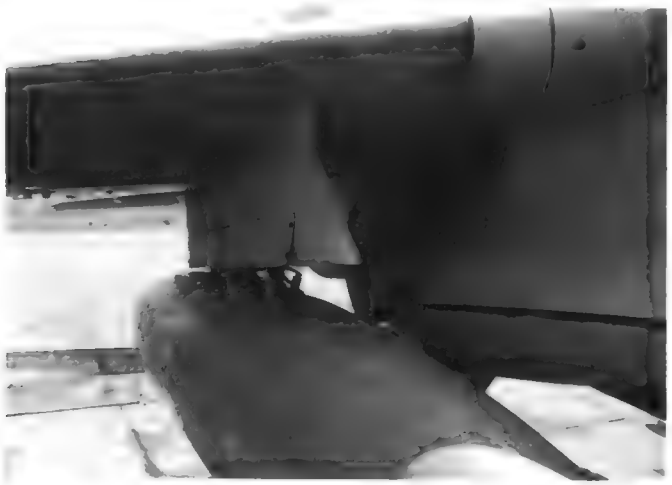
The A-6's main task is close air support, which means working in conjunction with ground troops – clearing obstacles, finding and destroying point targets such as bridges, roads (and the traffic on them), gun batteries and airstrips, taking out enemy strongholds, in fact having a go at anything within range that poses an immediate threat to the men on the ground and helping to make life for them more comfortable. The Intruder can do this job probably more efficiently than any other aircraft, and it does not have to wait for clear skies and bright sunshine.

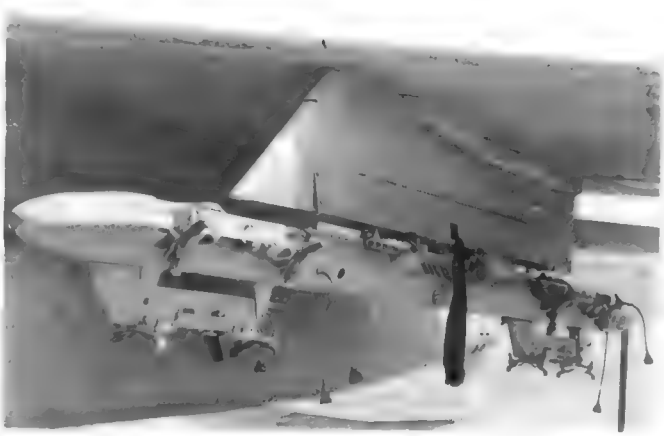
The five pylons, four under the wings and one beneath the fuselage, can each hold six-weapon multiple ejector racks (MERs), giving a total maximum load of thirty 500lb bombs – a lifting capacity of nearly 17,000lb (a 500lb Mk 82 weighs a bit more than its terminology suggests, and then the rack itself has to be counted); or triple ejector racks (for which typical loadings might be three 1000lb Mk 83s or 750lb Mk 117s); or single racks for 2000lb Mk 84s; or 300 US gallon fuel tanks; or a combination of these stores. Other options for this mission include add-on guidance packages such as the TV-homing HOBO (2000lb Mk 84, 3000lb Mk 118 bombs) and laser-guided Pave Way (applicable to the Mks 82, 84, 117 and 118 GP bombs and the Mk 20 Mod 2 Rockeye cluster bomb).

Secondary missions include hi-lo-hi long-range attack, quoted maximum unrefuelled radius being 870nm, for which the aircraft carries one weapon centreline and four fuel tanks; and hi-hi-hi long-range attack, nuclear or conventional, with the aircraft similarly configured but with the consequent fuel economy boosting radius to a quoted 1383nm. These figures presumably imply a cruise-dash-cruise flight plan and do not involve mid-air refuelling. In addition, the A-6E can itself turn tanker with the 300 US gallon centreline air refuelling store. The usual array of retarded bombs, pyrotechnics and practice bombs can be carried, as well as Shrike, Standard ARM and HARM (High-speed Anti-Radiation Missile). Mines can be accommodated for the anti-shipping role, and a recent addition to the armoury has been the AGM-84 Harpoon missile, employed with success by Intruders in the March 1986 skirmish in the Gulf of Sirte between the US Sixth Fleet and Libyan fast attack craft. Harpoon is about 12ft long, subsonic, and equipped with its own radar system so that it can home on its target independently of the launch aircraft. Released at an altitude at which the A-6's sensors first acquire and identify the ship it wants to hit, it descends to a sea-skimming flight profile, terminating in a short climb and dive before impact.

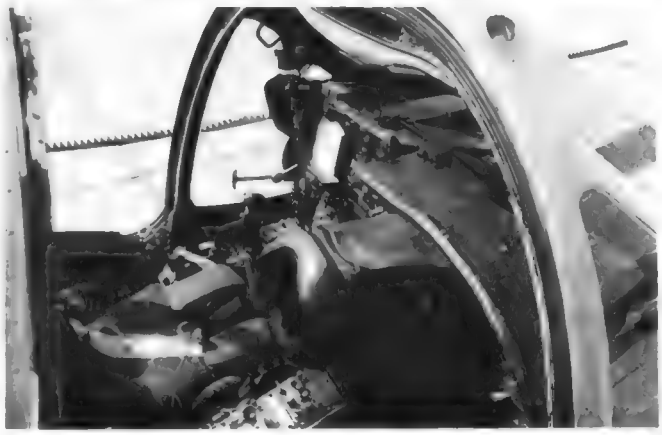
Overland, TRAM has brought an extra dimension to the Intruder's versatility, since targets can for the first time be defined and categorised according to temperature variations, thanks to the infra-red imagery which comes to the bombardier/navigator (B/N) on a TV-type display above his main radar presentation; moreover, classification can take place without the A-6 having virtually to overfly its target and, IR being a passive sensor, without the frustrations of having its signals jammed by ECM. This welcome 'stand-off' capability is complemented by the laser acquisition/ranging equipment installed in TRAM, which can either designate targets autonomously or pick up reflected laser energy produced when a forward air controller (FAC) on the ground illuminates the spot he wants hit. The aircraft can land the goods right on the target in a single pass, and the tracking mobility of the TRAM turret means that the data can still stream in when the aircraft is manoeuvring in the target area.

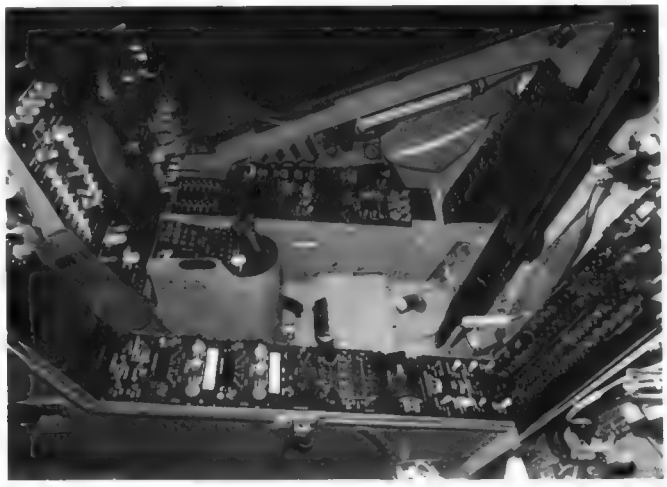
Opposite page: Blast screens erected behind them, two Intruders from VA-35 ('Black Panthers') await launch from the carrier *America* during operations in the Vietnam War, 1974. The aircraft furthest from the camera is a KA-6D tanker, its drogue housing visible beneath the rear fuselage. *Grumman Corporation*
Above: An A-6 armed with general-purpose bombs and a pair of AGM-88A HARM (High-speed Anti-Radiation Missiles). *Grumman Corporation*
Below: Two views of the standard 300 US gallon underwing tank.
Bottom left: Underfuselage stores station, nestling neatly in the trough formed between the engine casings.
Bottom right: Multiple Ejector Rack (MER), inboard station.

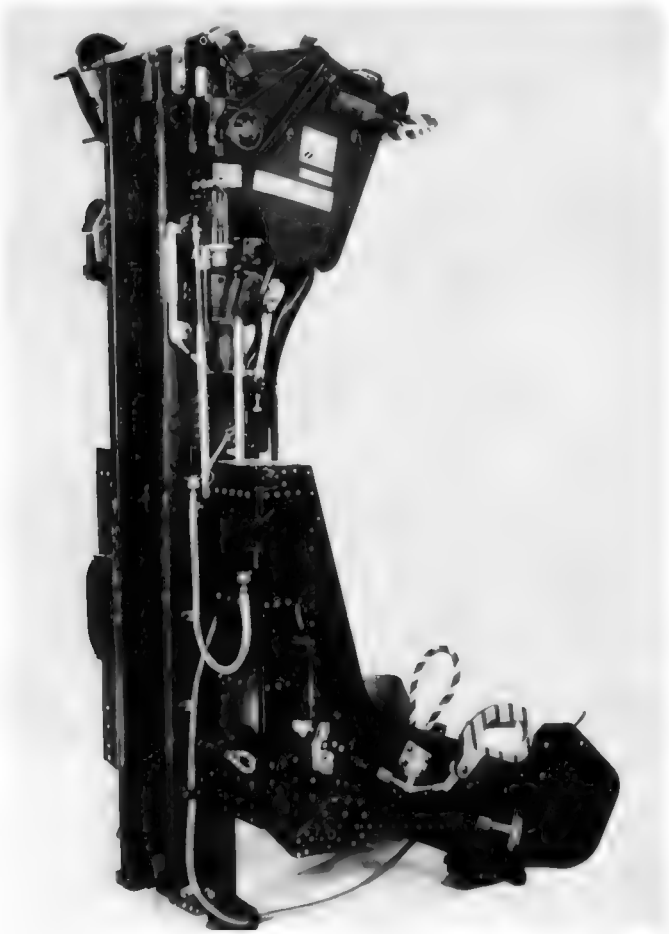


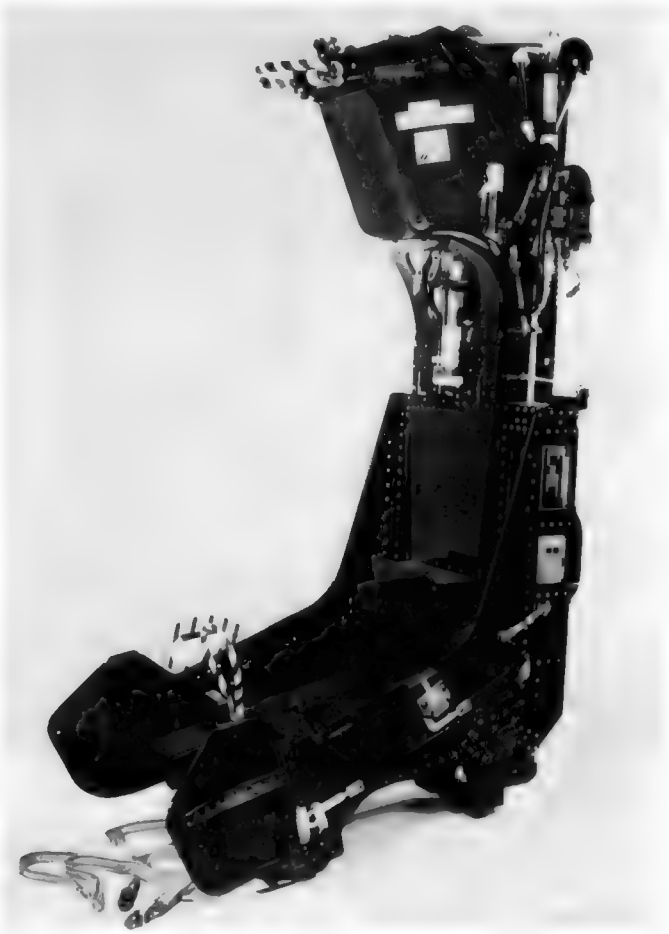


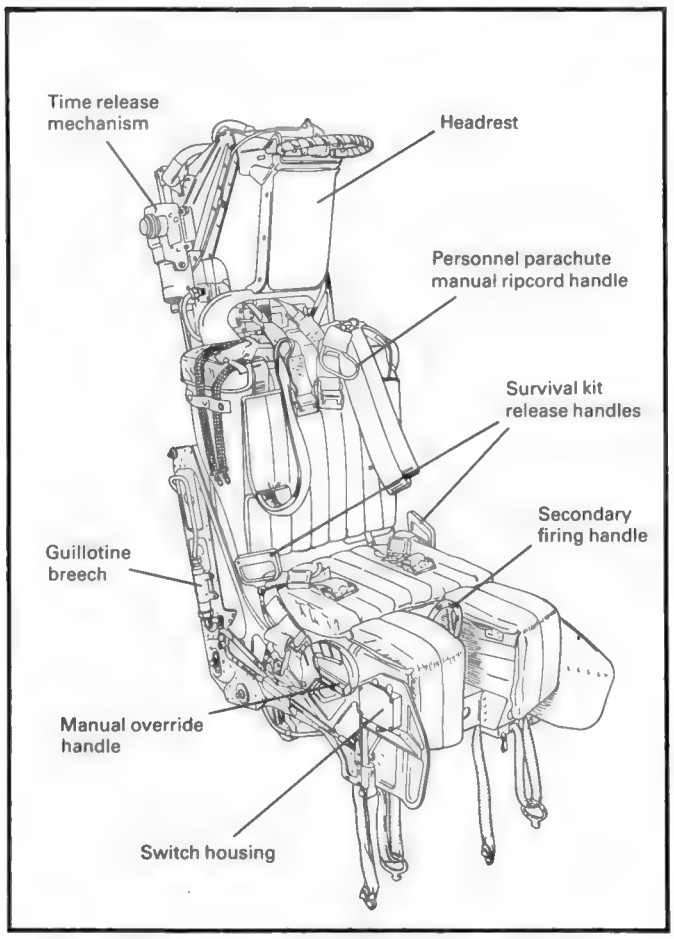
Above: A-6E TRAM pilot's (left) and bombardier/navigator's (right) instrument panels and consoles. The instrumentation is a mix of old and new, with traditional dials flanking the pilot's vertical display indicator and an optical sight mounted above. Central to the B/N's panel is his radar screen, with slewing control stick on the console below. The Intruder cockpit is exceptionally roomy (there is even a special stowage facility for sandwiches and four 1qt thermos bottles!) but, although the view through the sides of the canopy is good, visibility forward and rearward is limited. *Grumman Corporation*
Right: The B/N's radar display is fitted with a shroud, as seen in this A-6E TRAM cockpit view.
Below: Side views of pilot's (left) and B/N's (right) positions with ejection seats removed. *Grumman Corporation*
Opposite page: Four views illustrating the Mk GRU-7 ejection seats as fitted to the A-6E. *Martin-Baker Aircraft Co*

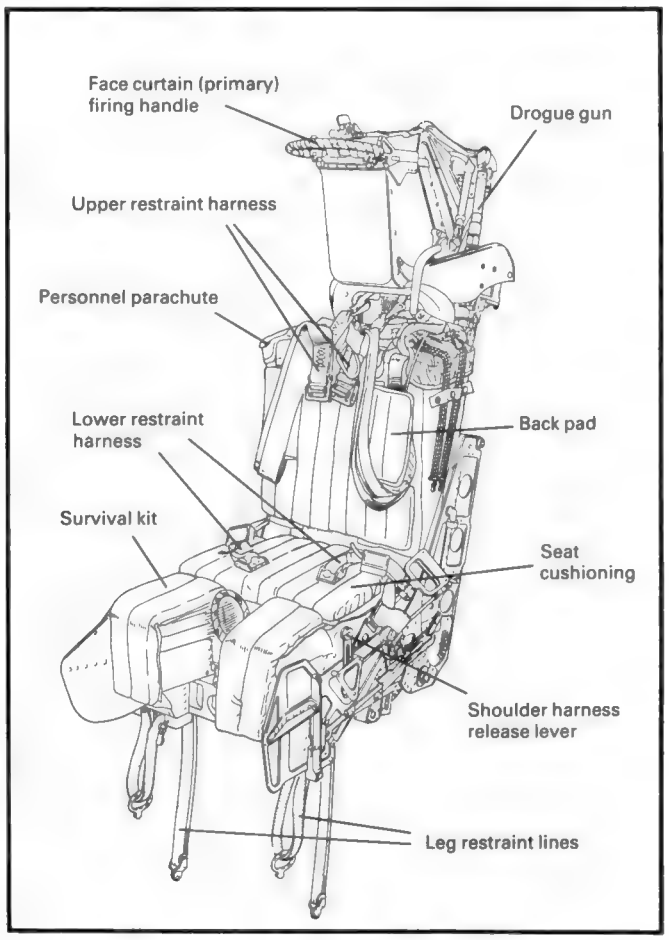









Time release mechanism
Headrest
Personnel parachute manual ripcord handle
Survival kit release handles
Secondary firing handle
Guillotine breech
Manual override handle
Switch housing


Face curtain (primary) firing handle
Drogue gun
Upper restraint harness
Personnel parachute
Lower restraint harness
Back pad
Survival kit
Seat cushioning
Shoulder harness release lever
Leg restraint lines

SQUADRON SERVICE

The A-6E Intruder serves with both the US Navy and the US Marine Corps; to date, it has not appeared on the inventories of any other service, domestic or foreign. It first showed up in USN colours in late 1971, when VA-42 (Attack Squadron 42), at NAS Oceana, Virginia, began to phase in aircraft alongside existing A-6As. VA-42 was and still is the Atlantic Fleet's A-6 training unit, and is permanently shore-based; in the summer of 1974 the Pacific Fleet's Intruder training unit, VA-128, began to receive A-6Es at NAS Whidbey Island, Washington.

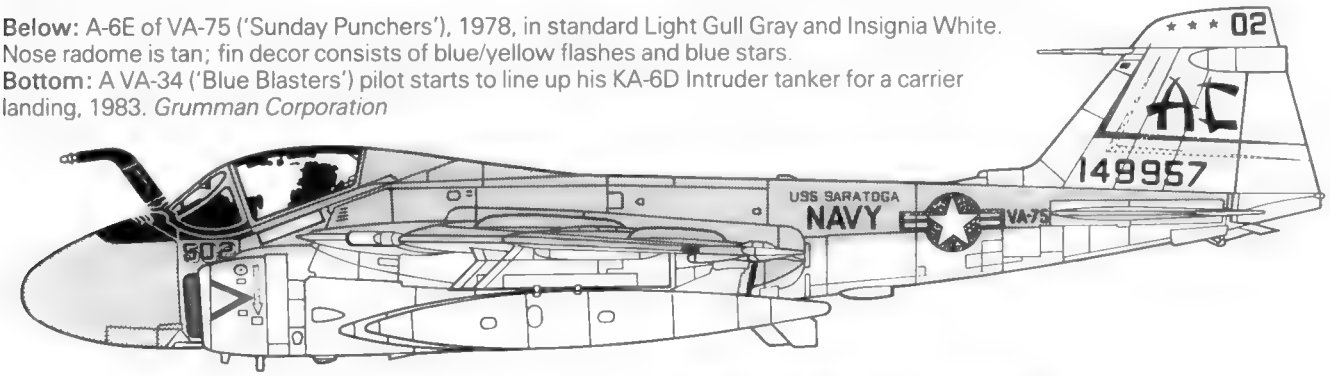
The first fully operational A-6E squadron was VA-85, again in late 1971 at Oceana, and through the early 1970s this unit was joined successively by VA-65, -34, -35, -75 and -176. Conversion to the new aircraft for the Pacific Fleet got under way somewhat later, with VA-52, -165, -196, -95, -115 and -145 at Whidbey Island, 1974–77, whilst VA-55, Atlantic Fleet, was commissioned specifically to operate the A-6E in 1983. The US Navy's Development Squadron, VX-5, took on A-6Es in 1971. Based at China Lake in California, this unit is tasked with the evaluation of weapons systems and mission tactics, and maintains combat readiness and carrier qualification just like any other front-line unit.

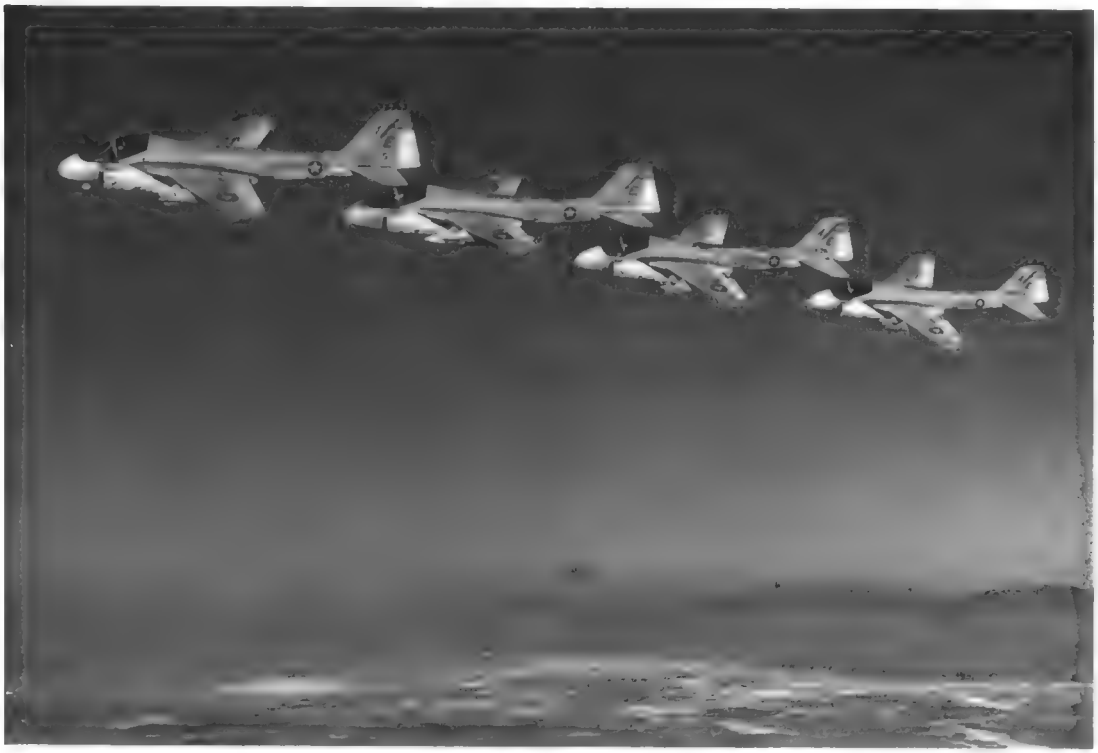
The US Marine Corps' A-6 training unit is VMAT(AW)-202 (Marine All-Weather Attack Training Squadron 202), stationed permanently at MCAS Cherry Point, North Carolina. The Squadron began to receive A-6E Intruders in mid-1974, and since then VMA(AW)-121, -224, -242, -332 and -533 have commissioned. USMC Intruder units are located both at Cherry Point and at El Toro, California, and one squadron is always to be found at MCAS Iwakuni, Japan (units take their turn at fulfilling this deployment).

Intruders of both the USN and USMC are now generally to be seen sporting a very subdued camouflage finish, details of which are presented on pages 34 and 35.

Brand-new A-6Es will continue to be produced for the squadrons at an annual rate of half a dozen aircraft until 1989, by which time the first of the A-6Fs will also have been completed. As these words are written, the Navy is getting down to the serious business of studying the options for a 21st-century medium attack aircraft for the Fleet. It already has a project title – Advanced Tactical Aircraft, or ATA. It will probably be subsonic, it will no doubt have turbofan engines, and it will certainly be packed with the very latest miracles of avionics technology. If this sounds like yet another born-again A-6, nobody should be surprised.

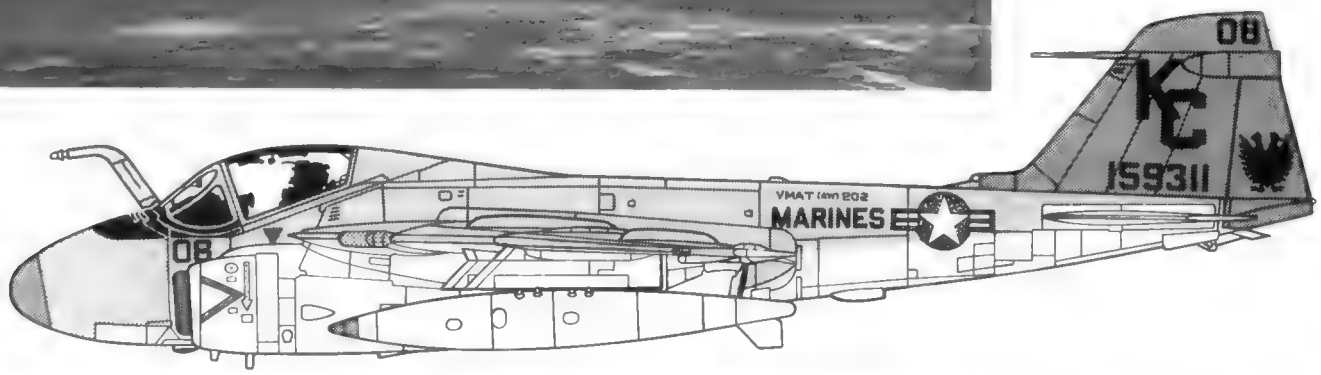
Below: A-6E of VA-75 ('Sunday Punchers'), 1978, in standard Light Gull Gray and Insignia White. Nose radome is tan; fin decor consists of blue/yellow flashes and blue stars.
Bottom: A VA-34 ('Blue Blasters') pilot starts to line up his KA-6D Intruder tanker for a carrier landing, 1983. *Grumman Corporation*





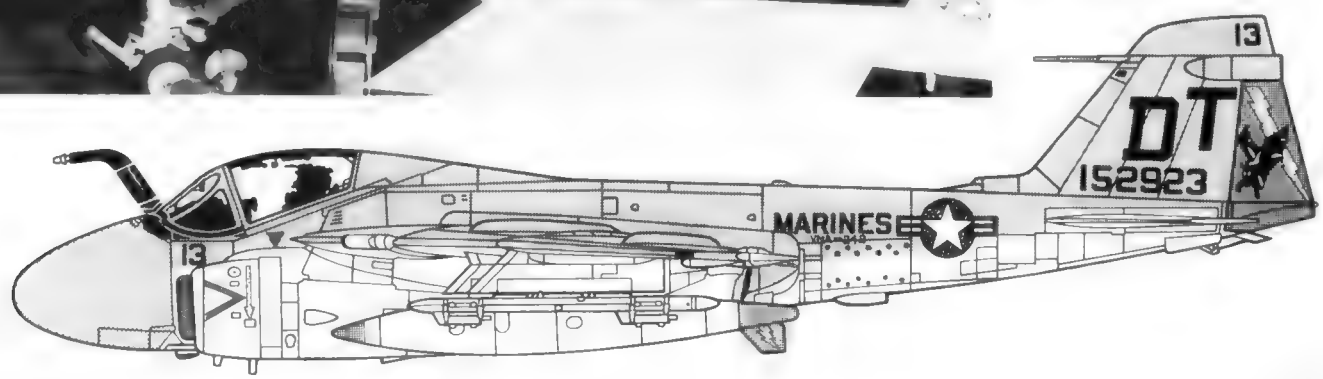
Left: Four A-6E Intruders of VA-176 ('Thunderbolts') out from Fallon, Nevada, 1981; only the lead aircraft has its TRAM turret, and only the first two have full anti-glare panels. Some 'toning down' of the markings is evident, although the overall finish is still Light Gull Gray and Insignia White, with standard-colour national insignia. *US Navy*

Below: VMAT(AW)-202 A-6E during 1978 in grey/white finish and with orange-tipped tan radome. Tips of underwing tanks and entire fin and rudder are also orange, the latter carrying black unit insignia. Note Light Gull Gray inflight-refuelling probe and white panelling at base of radome.

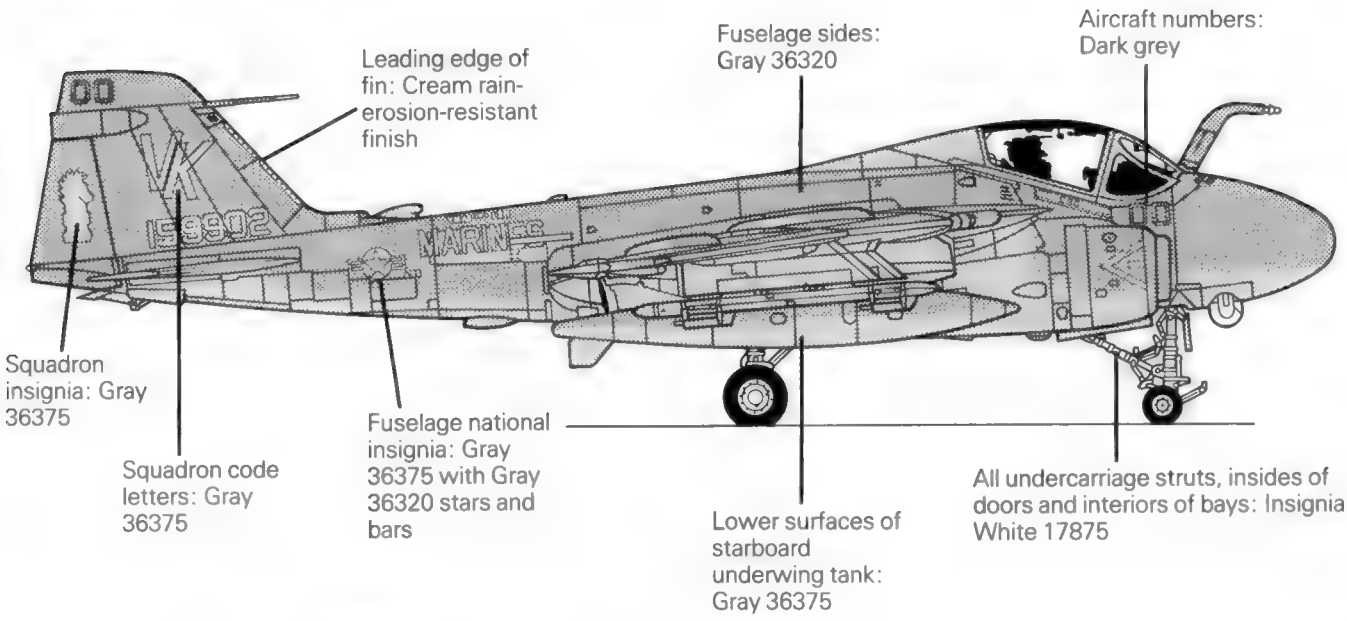


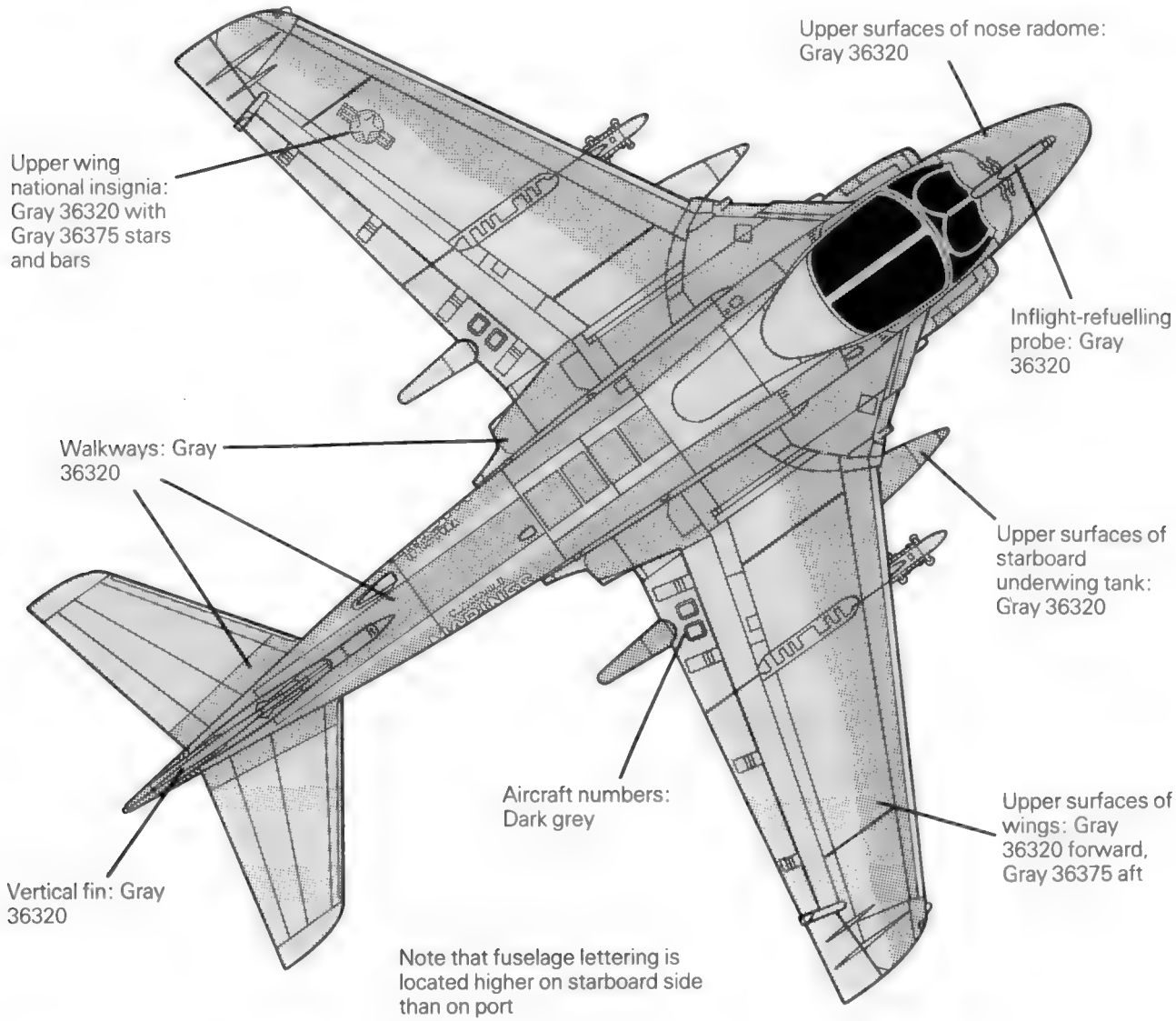
Left: 'But you told me you'd put an extra seat in . . .!' Crewmen board an A-6E Intruder assigned to Carrier Air Wing 9 (CVW-9), USS *Constellation*, April 1980. Intake rim, splitter plate and warning chevron are painted red. This photo indicates just how big an aircraft the Intruder is. *US Navy*

Below: VMA-242 ('Batmen') A-6E, 1978–79, in standard 1970s finish with tan radome Underwing tanks are tipped in medium blue; rudder is blue with black and white bat and yellow flash.



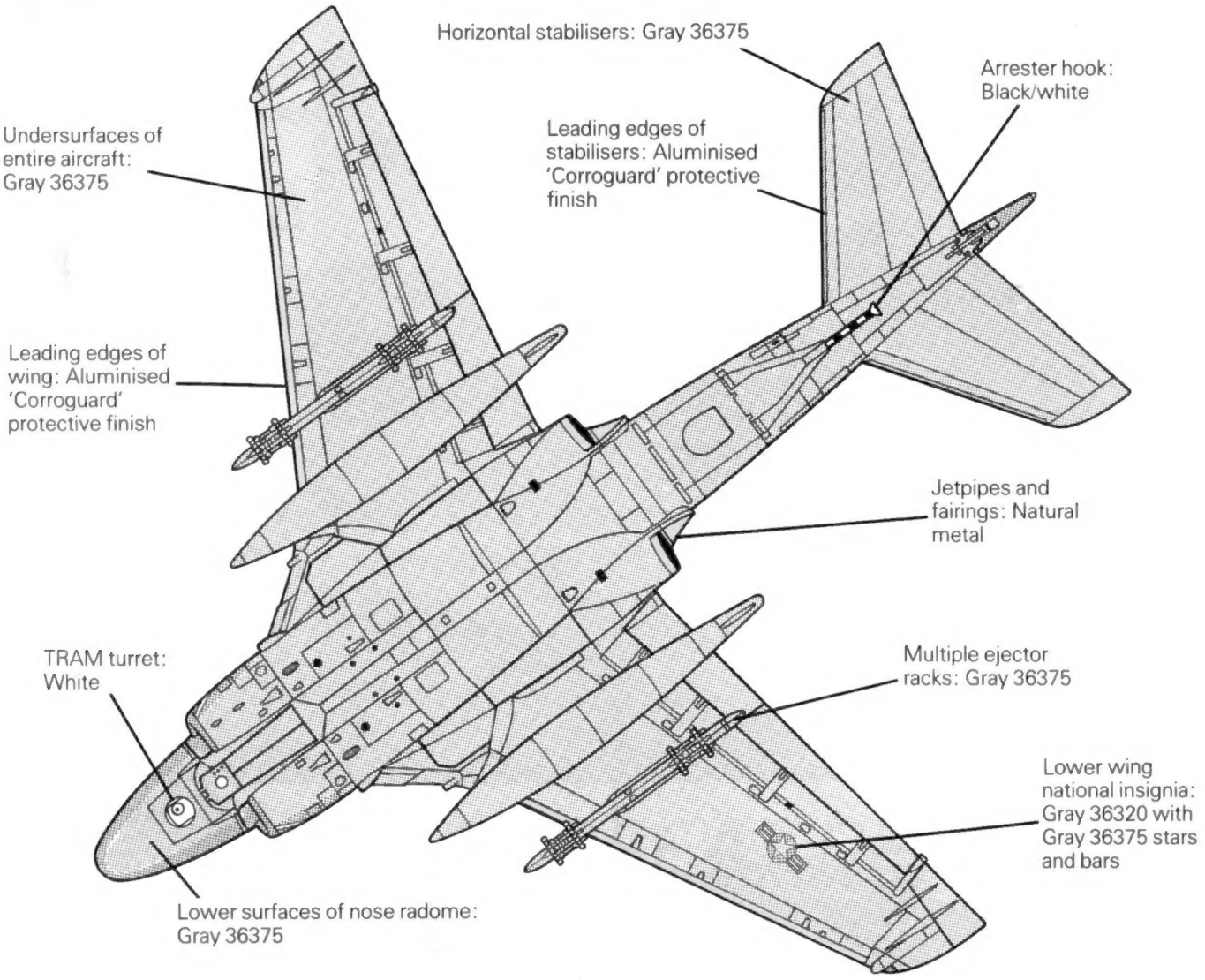
GRUMMAN A-6E TRAM INTRUDER, VMA(AW)-121, 3rd MAW, MCAS EL TORO, MAY 1985



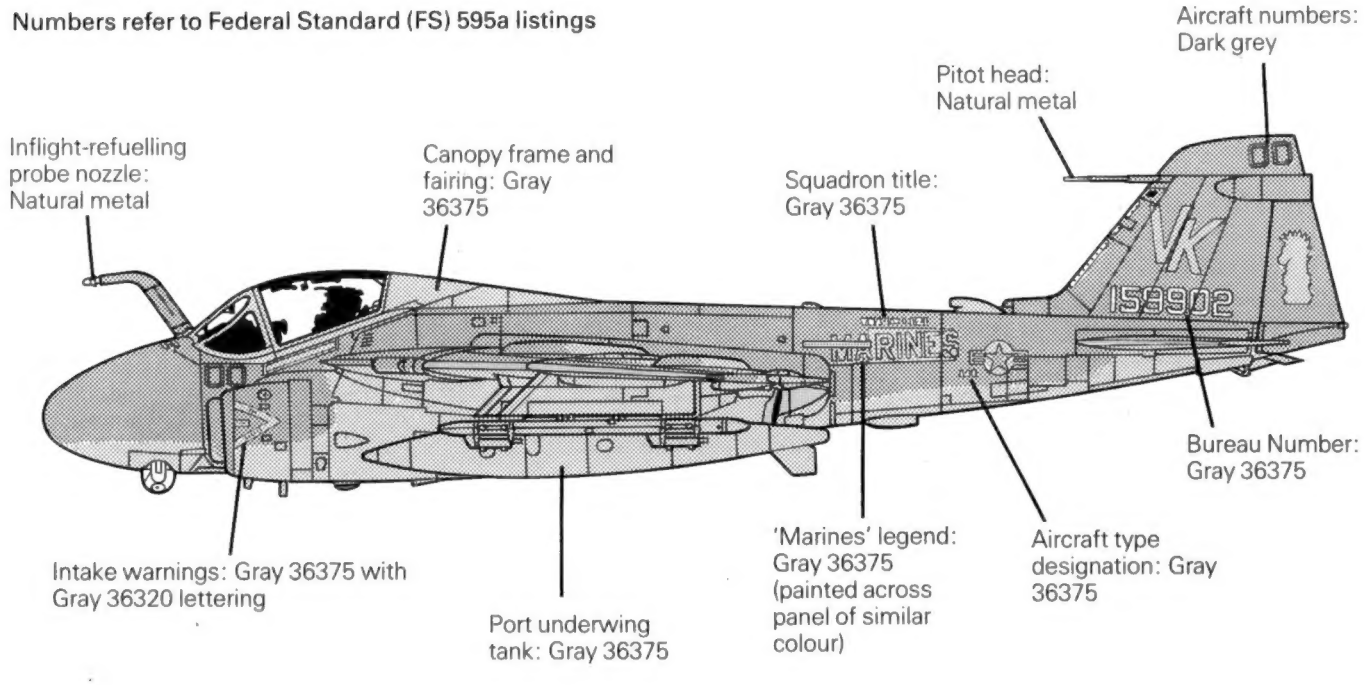


Note that fuselage lettering is located higher on starboard side than on port

1:96 scale

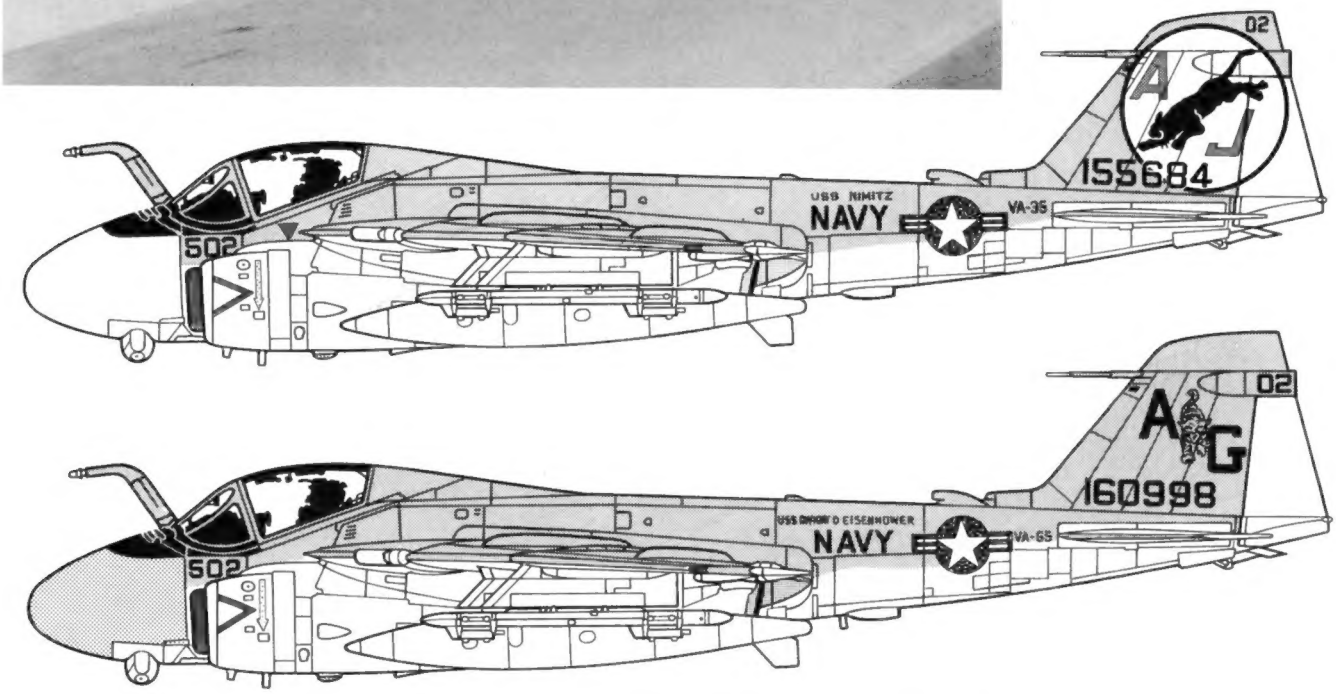


Numbers refer to Federal Standard (FS) 595a listings



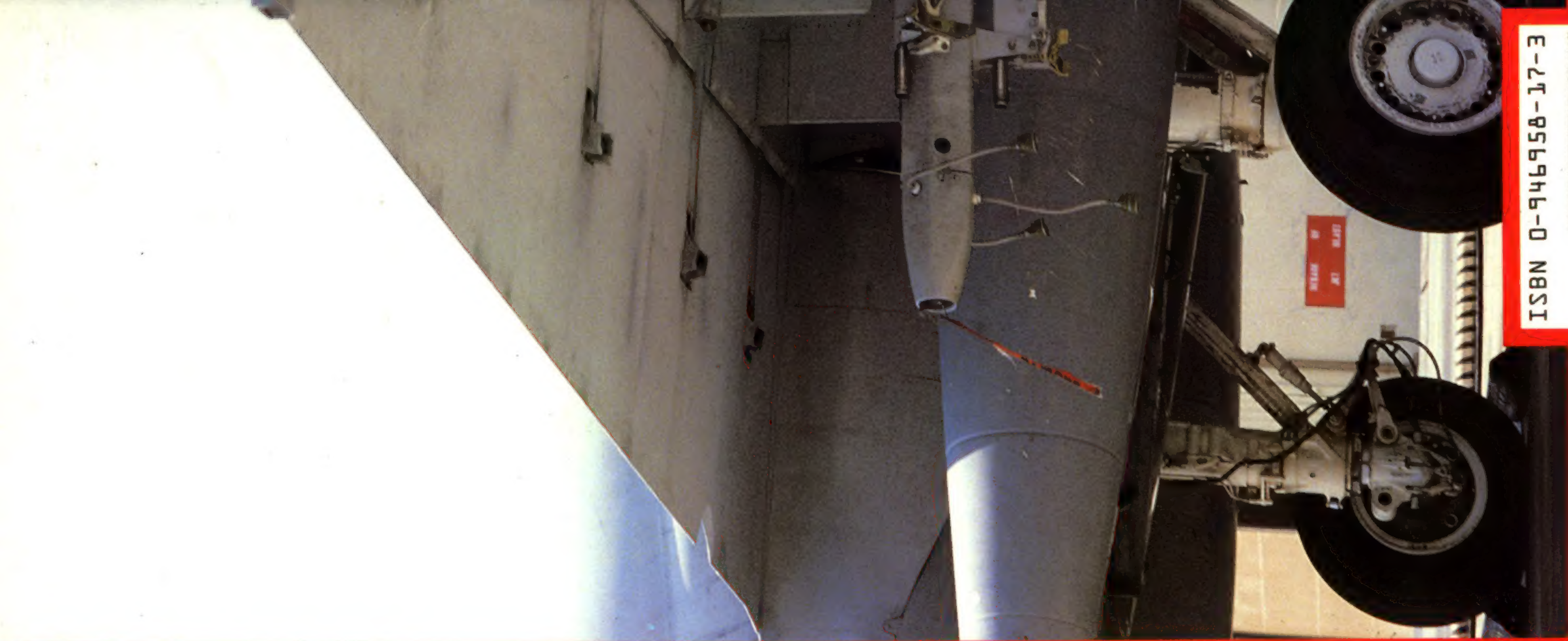
Left: Marine Corps Intruders from VMA(AW)-332 ('Moonlighters') photographed from a C-9, 1981. Tail codes on USMC aircraft identify the user squadron, those on USN machines the Carrier Air Wing (which typically includes three attack squadrons, one of which is an A-6 unit). *US Navy*

Below: A VA-35 A-6E TRAM, 1981. Colour scheme is still Light Gull Gray and Insignia White. The 'Black Panthers' tail motif is set off within a white disc, the flanking CVW codes being medium green. Intake splitter plates are red.



Above: Buff-nosed A-6E TRAM flown by VA-65 ('Tigers'), late 1970s; fin emblem is black.

Left: A camouflaged fuel bowser trundles past the VMA(AW)-242 flight line at MCAS El Toro, 1985. Even at this short range it is extremely difficult to distinguish the large unit codes on the A-6E's fin, thanks to the low-contrast paints used. The tactical colour schemes were introduced in the early 1980s after a period of experimentation, and they have proven highly successful; one suspects that, in the air, the first visual clue to the presence of an Intruder will be the glint of its canopy. Maybe one day all the flamboyance will return.



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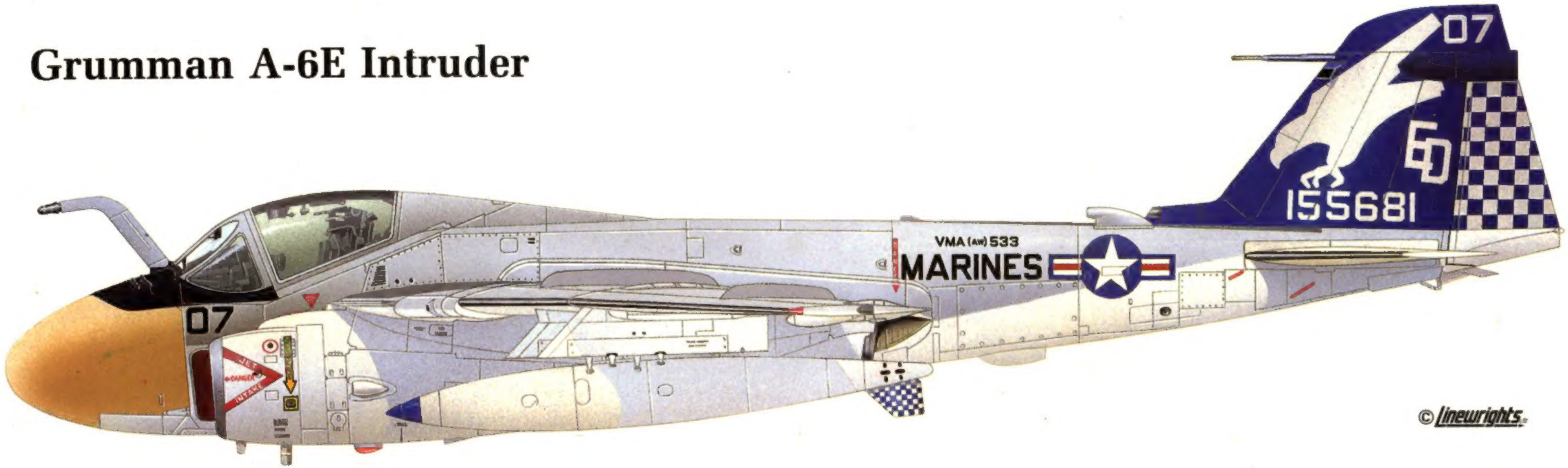
Grumman A-6E Intruder



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